This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

3 3433 06274287 3

3-OR
Annual

ANNUAL
OF
SCIENTIFIC DISCOVERY:
OR,
YEAR-BOOK OF FACTS IN SCIENCE AND ART,
FOR 1871,

EXHIBITING THE
MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS
IN
MECHANICS, USEFUL ARTS, NATURAL PHILOSOPHY, CHEMISTRY,
ASTRONOMY, GEOLOGY, BIOLOGY, BOTANY, MINERALOGY,
METEOROLOGY, GEOGRAPHY, ANTIQUITIES, ETC.,

TOGETHER WITH

NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1870; A LIST
OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF
EMINENT SCIENTIFIC MEN, ETC.

EDITED BY
JOHN TROWBRIDGE, S.B.,
ASSISTANT PROFESSOR OF PHYSICS IN HARVARD COLLEGE;
AIDED BY
W. R. NICHOLS,
ASST. PROF. OF CHEMISTRY IN MASS. INST. OF TECHNOLOGY;
AND
C. R. CROSS,
GRADUATE OF THE INSTITUTE.

BOSTON:
GOULD AND LINCOLN,
59 WASHINGTON STREET.
NEW YORK: SHELDON AND COMPANY.
LONDON: TRÜBNER & CO.
1871.

THE NEW YORK
PUBLIC LIBRARY
[illegible]
ASTOR, LENOX AND
TILDEN FOUNDATIONS.
1897.

THE ASTOR LIBRARY
N Y

Entered according to Act of Congress, in the year 1871, by
GOULD AND LINCOLN,
In the office of the Librarian of Congress, at Washington.

ROCKWELL & CHURCHILL, Printers, Boston.

NOTES BY THE EDITOR,

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1870.

In looking over the material collected during the year, which is now embodied in the present volume, we find little that is new or startling in the province of the mechanic arts.

Both in this country and in England attention is fixed upon more economical and safer processes in applying inventions. The American manufacturer would do well to read the report on steam-boiler legislation presented at the meeting of the British Association. Among the names of the committee who presented it we find those of Sir William Fairbairn and Sir Joseph Whitworth. From the report it appears that about 50 explosions occur in Great Britain every year, killing about 75 persons and injuring as many others. The committee are confirmed in their opinion that explosions are not accidental, that they are not mysterious; but that they arise from the simplest causes, and may be prevented by the exercise of common knowledge and common care. Boilers burst simply from weakness. Competent inspection is adequate to detect the weakness of the boiler in time to prevent explosions, whether that weakness arise from malconstruction or defective condition, while it tends to stimulate attendants to carefulness, and thus to diminish the number of those explosions arising from oversight.

The committee state that for every explosion due to the boiler-minder in neglecting the water supply, etc., six are due to the boiler-maker or boiler-owner from making or using bad boilers. After discussing possible remedies the committee are convinced that the government should enforce the periodical inspection of all steam boilers. The numerous explosions of the year bring this subject home to us.

We can point with pride to some substantial engineering work of the past year: notably, the building, launching, and placing the great caisson at the Brooklyn terminus of the East River bridge. An extract from the report of Col. Roebling will be found in the present volume.

It is stated that the great central shaft of the Hoosac Tunnel has reached the grade of the tunnel 1,030 feet below the natural surface.

The Broadway Underground Railway is well underway; the construction progressing while the thoroughfare above is crowded with its endless procession of vehicles.

The St. Louis bridge, under the able engineering skill of Captain Eads, progresses finely.

The removal of the obstruction at Hellgate is continued day and night. These and the work of the coast survey testify to the presence of engineering skill among us.

The European war has not called forth to a large extent the inventive capabilities of our population, while it has had distinctly this effect abroad. Activity, however, among the American manufacturers of arms and ammunition has necessarily followed.

As a proof of the esteem in which American weapons are held abroad it is stated that the Remington Co., N. Y., have exported to Denmark 25,000 breech-loaders, and as many to the Swedish government. Colt's Co., 30,000 Berdan rifles to Russia. Turkey has also been a large purchaser. Nearly the half of the work of Smith & Wesson's manufactory is bought by European parties. And the Union Metallic Cartridge Co. send their products to all parts of the world.

We learn, from the "London Broad Arrow," that "12 of the Gatling guns of 45-bore have been ordered from America for the government absolutely, and 50 additional on the understanding that they will be taken. Meanwhile, 50 more of these guns are being manufactured by Sir William Armstrong, at the Elswick ordnance works, in expectation that they also will be taken by the government. As it is understood to be the intention of the government to arm each of the ships of war with a mitrailleuse, in addition to supplying a certain number to the army, it is clear that several hundreds of this arm will be required."

The new explosives, nitro-glycerine, dualin, lithofracteur, and dynamite have received considerable attention during the past year. Full accounts of dualin will be found in the present volume; it seems to promise well for certain kinds of work, although the authorities at the Hoosac tunnel do not speak very favorably of it. It consists, as do most of these new explosives, of nitro-glycerine, with some comparatively inert base: in the case of dualin the base is sawdust.

The manufacturers of iron are quickly adopting the latest inventions, but have given us no very new modifications or improvements during the year.

Mechanical stoking is attracting considerable attention, and an able paper on this subject was delivered at the meeting of the British association, which can be found on page 23.

The European war has not added materially to the list of inventions of arms of warfare. The merits of the chassepot and the needle-gun have been actively canvassed, but on account of the physical superiority and training of the German over the French soldier, the trial between the weapons has not perhaps been a conclusive one. The mitrailleuse has also come in for its share of praise and abuse. It is thought to be a good weapon for mowing down a close assaulting column, but not for general field work.

It is stated that the projectiles of the chassepot and the mitrailleuse reached an enormous distance in the recent contests. According to the "Lancet," the number of thigh wounds made by bullets was relatively very great in the late battles; and the wounds made by the French sword-bayonet more difficult to heal than those of the Prussian triangular weapon.

The loss of the "Captain" will necessarily call attention to the safer construction of iron-clads.

At the meeting of the British Association, Captain Rowell presented his claims of the superiority of hemp cables over iron and hemp cables, and asserted that the hemp cable would be 50 per cent. cheaper than the present system.

The recent interruption of telegraphic communication with Europe will result, undoubtedly, in the laying of more cables.

A cable between England and France, from Beechy Head to Cape Antiper, near Havre, is in process of construction. It is to be an independent line, and is much needed on account of the pressure of business upon the other cables.

Considerable attention has been paid lately to the use of wire-rope tramways. The late Mr. Roebling, by perfecting the manufacture of iron cables, undoubtedly led the way to this result. In mining districts, on steep inclines, and even on ordinary transportation lines, the telo-dynamic system seems destined to play an important part. In England, 13 lines, varying from short distances to 4 miles in length, have been constructed, and upwards of 100 miles are in course of preparation or under contract.

The Suez Canal is a successful fact.

At the meeting of the British Association, General Heine read a paper on "Lines for Ship Canals across the Isthmus of Panama." He concluded that only two lines were deserving of consideration, because of the expense for constructing and working them. The two lines were, first, from Aspinwall along the line of the railway to Panama, with an extrême elevation of 269 feet, a length of 35 miles through rocks of porphyry and basalt, and with but middling ports of entry; second, from the Gulf of Darien through the rivers Atrato, Caiarica, Paya, and Tuyra, to the Gulf of San Miguel, with an extreme elevation of 186 feet, length 52 miles, through soil composed of alluvial deposit, with some thin ranges of grayish sandstone and schist, and with very good ports of entry. The speaker urged upon Englishmen a greater interest in this canal, which would so materially shorten the marine passage to Australia, the west coast of America, and the islands of the Pacific Ocean.

This year marks the completion of the Mount Cenis Tunnel.

The use of artificial stone is on the increase. In many regions of our country, where stone and timber are scarce, the use of concrete in building would seem to find favor. Among the later inventions may be instanced that of the Rev. H. Highton, of England, which utilizes the refuse of granite quarries.

A paper on International Communication in the present volume will prove of interest to all who are afflicted with sea-sickness.

Mr. Bessemer proposes to construct a chamber or state-room which shall accommodate itself to the motions of the ship,—somewhat as a lamp hung upon gimbals. This chamber is to be luxuriously fitted up, and to be carefully shut off from the air of the boilers and engines. The expense of such an arrangement seems to be the only feature that will militate against so desirable an improvement.

The watering of streets with chemicals has attracted favorable attention abroad. At the meeting of the British Association, Mr. J. W. Cooper, who has given much attention to this subject, stated that three streets in the city of Liverpool were watered with salt during the month of July, 1869, with very favorable results, — so much so, that the experiments were continued this year.

Mr. Cooper proposes to add a certain portion of the deliquescent chloride of aluminum to the salts used, and, by its antiseptic qualities, afford a means of more thoroughly purifying thoroughfares.

Photography applied to military purposes is not new, but the English government are making greater use of it than ever before.

Photographs are taken of soldiers exercised in the manual of arms, — both in the infantry and the artillery service; of the lading of sumpter mules, and, in short, of everything which can convey information to new recruits in the colonies.

The preservation of meat has long attracted much attention in this country and in Europe. The exportation of preserved meats from Australia is becoming a business of great importance. Since the opening of the Pacific Railroad fruit and meat have been transported to the Atlantic sea-board in closed refrigerator cars. In this connection it is well to notice the increased use of artificial ice. The French company Messageries Impériales, wishing to ascertain what kind of ice would be preferable for the vessels navigating the Suez Canal, caused experiments to be made under identical circumstances, and apparently proved that artificial ice would have the preference over natural ice for transportation, and for refrigerating mixtures. More experiments, however, are needed to establish this fact.

A paper on the continuity of the gaseous and liquid state of matter, by Dr. Andrews, will be found on page 128; the transition from the gaseous to the liquid state is shown not to be abrupt, but that the two states are connected by a continuous change. The writer infers, also, that liquids change to solids by a similar law. The recent experiments made by M. Andre, on the velocity of sound in water, give the velocity as 1206.5 metres per second. Wertheim, it will be remembered, found it 1173 metres per second, and MM.Colladon and Sturm, 1435 metres per second. Koenig's investigation of the vowel sounds, supplementary to Helmholtz' researches on the same subject, are interesting in a philological point of view. He infers from the simplicity of the ratio of the vibrations of the five vowel sounds found in all languages, the reason of their universal adoption.

M. Jamin has extended the use of electric currents to the determination of latent heats and specific heats. In this connection it is well to mention Siemens' resistance pyrometer. This instrument will measure intense heat; it is based upon the principle that metals offer a resistance to the passage of an electrical current when they are heated,—this resistance increasing in a determinate ratio. Efforts have long been made to invent an accurate pyrometer. Experts state that this pyrometer promises to be very useful.

The new galvanic battery, invented by Bunsen, evolves no fumes in working, and is quite constant. Consisting merely of one liquid, a mixture of sulphuric and chromic acids, no porous cells are needed.

The experiments on the Atlantic Cable, conducted by Dr. Gould, can be found on page 155.

The general reader will be interested in the fact that messages were effectually and distinctly transmitted in each direction by the use of an electrometer formed by a small percussion cap containing moistened sand, upon which rested a particle of zinc.

Colonel Woodward, of the Army Medical Museum, Washington, has made a series of experiments in microscopic photography, using the magnesium and electric lights. His results are very successful. The lime light and the magnesium light had been used before in this connection, in England, but not with great success.

Measurements of Newton's rings made some years since by Fizeau, together with the wave length of the light of the two principal components of the D line of the solar spectrum, show a remarkable coincidence in results obtained by different methods, and further confirm the truth of the undulatory hypothesis. (See page 151.)

We incorporate herewith the notes of Professor Nichols, on the progress, during the past year, in Chemistry and Geology.

"During the year considerable progress has been made in organic chemistry so-called. As a rule, however, much of the work done, and most of the results obtained, appeal to the minds of a very few even among scientific men. Still these researches ought not to be decried by practical men, in the face of such a brilliant result as the artificial production of alizarine. (See page 182.) The artificial product seems to be identical in physical and chemical properties with the natural coloring matter, and is already manufactured on a considerable scale. Worthy of mention, also, is the synthetical construction of indigo-blue, by Emmerling and Engler (see page 211), although the method employed offers no prospect of its production in quantities sufficient for manufacturing purposes. Moreover, our knowledge *of the constitution of* chemical substances, and the laws which govern them is increased and rendered more certain by the study of the more complex compounds occurring in nature, or produced, in the laboratory. While, therefore, there is great fascination attending the pursuit of this branch of the science, there are still many interesting objects of research in mineral chemistry to be investigated, still many problems in technical chemistry to be solved.

The definition of organic chemistry as the "chemistry of the compounds of carbon," felt to be so happy when first propounded, loses somewhat of its significance in view of the researches of Friedel and others (see page 193), which show that silicon is competent to replace carbon in the formation of many complex bodies. That the importance of silicon in the economy of organized existence has failed to be duly appreciated cannot be denied, although we may not be prepared to admit with Henry Wurtz, of New York City, that "*all silica in isolated forms appertains, in origin at least, to the vegetable kingdom.*" The researches of Thenard (see page 196) follow naturally those of Friedel and Landenburg.

As standing on the border line between chemistry and physics proper, we may signalize the investigations of Thomsen, of Copenhagen, on the heat of chemical combination. His determinations differ to a considerable extent from those of Favre and Silbermann, hitherto regarded as authority. As the result of his experiments he finds that when a molecule of acid is neutralized by a caustic alkali, the heat evolved increases nearly in proportion to the amount of alkali added until this amount reaches 1, ½, ⅓, ¼, of a molecule of alkali, according as the acid is mono-, di-, tri- or tetra-basic. Silicic acid forms an exception to this law, as do also, to a certain extent, arsenic, boracic, and ortho-phosphoric acids.

In this connection allusion must be made to the researches of Dr. Andrews, on the continuity of the liquid and gaseous states, which tend to show that the assumption of the existence of three distinct states or conditions of matter has no foundation in fact, the solid, liquid, and gaseous states being actually continuous.

While we have no actual proof of the truth of the atomic theory, and while many chemists are disposed to place this hypothesis even without the limits of probability, it is interesting to note that Sir William Thomson, from the consideration of physical phenomena, has been led so far as to *calculate the size* of the molecules *which go to make up* chemical substances. He concludes that in any ordinary liquid the mean distance between contiguous molecules is less than one one-millionth of a centimeter and greater than one two-millionth.

Dr. Angus Smith, in England, in connection with his work as Inspector under the Alkali Act, has been carrying on chemical examinations of the air and rain in various localities, and collecting statistics looking towards the establishment of a new branch of meteorology, — chemical climatology. While the methods of analysis are already tolerably satisfactory as far as the determination of the various gases naturally or accidentally present in the air, and of the various saline matters contained in the rain, the great problem bearing upon health — the determination of the amount of organic matter in the atmosphere and its character, whether harmless or injurious — is still far from being solved.

While in *technical chemistry* there is little to record that is strictly new, attention may be called to the great change wrought in one of the most important of the applications of chemistry to the arts, namely, the manufacture of chlorine. Weldon's process (see page 166), announced at the meeting of the British Association in 1869, is supplanting the old method, to considerable extent, both in England and on the continent. That the process is, however, still imperfect, is evident from the fact that two-thirds of the chlorine in the chlorhydric acid employed goes to waste. The ingenious process of producing chlorine without the use of manganese, suggested by Henry Deacon (see page 169), while theoretically excellent, presents practical difficulties which have not been surmounted so as to bring the method into actual use.

Geology. — The most interesting results which have recently been obtained have been the results of the deep-sea dredgings, carried on along the Atlantic coast on both sides of the ocean, with assistance from the governments of Great Britain and the United States. The facts thus obtained in regard to the mode of deposition of calcareous and other sedimentary rock-strata, and in regard to the distribution of animal life, are of the highest importance. It seems that there is no limit to the depth at which animal life can exist; many genera and species, heretofore considered extinct, have been found to have living representatives; the influence of warm and cold currents is shown to be very great on the fauna of a given area, so that side by side deposits are forming, one containing the remains of arctic, and another the remains of temperate or even tropical species. A somewhat detailed account of the results of these investigations will be found in subsequent pages."

Professor Huxley, in his address at Liverpool, contributed some new terms to science.

The hypothesis that living matter always arises by the agency of pre-existing living matter, he terms biogenesis; and the doctrine that living matter may be produced by not-living matter, abiogenesis.

It may be well also to notice two other terms greatly used in this branch of science: homogenesis and heterogenesis, or xenogenesis. When the living parent gives rise to offspring which pass through the same cycle of changes as itself, like giving rise to like, this is termed homogenesis; when the living parent gives rise to offspring which pass through a totally different series of states from those exhibited by the parent, and do not return into the cycle of the parent, — this is termed heterogenesis or xenogenesis; like not giving rise to like.

A late writer in "The Lancet" says: "The determination of the nature and mode of existence of the contagious principles of zymotic diseases has hitherto baffled the keenest search of scientific workers; but the employment of improved methods of observation is at length beginning to remove much of the mystery which envelops the subject of contagion. Until we have unravelled the nature of zymotic poisons, it is impossible to make any real progress in the discovery of efficient means of averting the spread of epidemic and contagious diseases. From the results of a special investigation, conducted for the Privy Council in England by Dr. Sanderson, we are led to the conclusion that every kind of contagion, as regards its physical form, consists of extremely minute, separate, solid particles, to which the name *microzymes* is given; these particles being spheroidal, transparent, of gelatinous consistency, of density equal to that of the animal fluid in which they are contained, and, therefore, not deposited by subsidence, and composed of albuminous matter. They are organized beings, self-multiplying organic forms. The results of M. Chauveau's experiments with small-pox, sheep-pox, and farcy poisons, all tell in the same direction. It is apparent that the tendency of recent researches is to induce a reaction in favor of the fungus origin of zymotic disease."

"The controversy about Spontaneous Generation, or Abiogenesis," remarks the "Lancet," "resembles history, — it continually *repeats itself.* Notwithstanding the discussions at the meeting of the British Association, the whole question is now relegated to the region of inquiries into the degree of heat that will be certainly destructive to the lower forms of life."

Dr. Bastian, in three articles ("Nature," vol. II., pp. 170, 193, 219), gives his reasons for believing that spontaneous generation does occur. He criticises Professor Huxley's address before the British Association in "Nature," vol. II., pp. 410, 431, and 492.

In the hydrated chloride of aluminium we have a new antiseptic.

At a meeting of the Boston Society of Natural History, June 1st, 1870, Mr. Edward S. Morse made a verbal communication on the position of the Brachiopoda in the animal kingdom. After stating observations made upon different species, especially upon the *Lingula pyramidata*, and upon alcoholic specimens of *Terebratula* and *Discina*, he concludes that the Brachiopods, together with the Polyzoa, should be removed from the Mollusca, and placed with the Articulates among the Annelids.

One cannot fail to notice that the workers in the different fields of biology and physics are both engaged in investigating the first conditions of matter, — the one striving after a knowledge of the germs of life; the other investigating the size of atoms and their existence or non-existence. Sir William Thomson, by his papers on the size of atoms (published in "Nature," vol. I., p. 551), has directed attention in a strong degree to Molecular Physics.

Professor Young, of Dartmouth College, has succeeded in photographing a solar protuberance. A way is thus evidently opened for preserving records of these eruptions. An important research upon the constitution of the sun has been published by Professor Zöllner. His results are as follows: —

The forms of the protuberances are divided into two groups, — vaporous or cloudy, and eruptive. The vesicles of vapor in terrestrial clouds only form the means through which the differences of masses of air become visible. The clouds of the protuberances are made visible by the incandescence of glowing hydrogen. Starting with the hypothesis that the eruptions are due to the difference of pressure of gases emanating from the interior and the surface of the sun, and assuming that there is a separating layer between the inner and outer strata of hydrogen, he follows out the mechanical theory of heat and gases, considering the eruptive protuberances due to the flow of a gas from one space into another, while the pressure in both is constant; neither communication nor absorption of heat being assumed. He finds *the absolute minimum* temperature in the space from which an eruption of 1.5 minute's height takes place, to be 40, 690° C., and from a protuberance of 3 minutes' height, 74, 910° C.

The maximum velocities of streams of gas moving vertically or horizontally in the chromosphere are from 40 to 120 English miles per second. According to the mechanical theory of heat such velocities of hydrogen necessitate differences of temperature amounting to 40,690° C. Having shown that the explanation of the eruptive protuberances necessitates the existence of a separating stratum between the space from which they emanate and the space into which they pass, we must assume a reference to its physical condition that it cannot be gaseous, and must, therefore, be either solid or liquid. The former is improbable on account of the high temperature; it is therefore concluded that the separating stratum consists of an incandescent liquid.

In reference to the inner masses of hydrogen, bounded by that stratum, two suppositions are possible: 1. The whole interior of the sun is filled with incandescent hydrogen gas, which would make the sun an immense bubble of hydrogen, surrounded by a liquid glowing envelope. 2. The masses of hydrogen, bursting out into protuberances, are local collections, in bubble-like caverns, which form in the superficial layers of a liquid glowing mass, and burst through when the presence of the confined gas increases.

Under the first supposition, stable equilibrium could only exist if the specific gravity of the outer layer is less than that of the gas below it. Since the density of a globe of gas, whose particles are subject to Newton's and Mariotte's laws, increases towards its centre, the specific gravity of the outer boundary layer must necessarily be less than the mean specific gravity of the sun. But if we take the mean specific gravity of the sun as the maximum of the liquid outer layer, we would be obliged to assume that all deeper layers, including the gaseous one immediately below, have the same specific gravity. Then the interior of the sun could not consist of a gas, but of an incompressible fluid. All these properties are clearly a necessary consequence of the supposition that the specific gravity of the compressed gases forming the protuberances reaches as its maximum the mean specific gravity of the sun.

In that case we must suppose, secondly, that the sun consists of an incompressible liquid, near whose surface there are collections of glowing masses of hydrogen, which break through bubble-like caverns, as eruptive protuberances under certain differences of *pressure.*

However small these caverns may be in special cases, the specific gravity of the enclosed gases cannot be greater than that of the surrounding liquid, because, otherwise, the compressed gases would sink towards the sun.

Professor Zöllner finds that, calling the pressure at a certain height above the base of the solar atmosphere, between 0.500 m. and 0.050 m., there results a mean temperature of 27,700°.

Iron must accordingly exist as a permanent gas in the solar atmosphere; from the value of $t = 27,700°$ the inner temperature is found to be 68,400°, and the pressure in the interior of the space from which the protuberances emanate is 22.1 times greater than the pressure at the surface of the liquid separating layer; the pressure at the base of solar atmospheres being 184,000 atmospheres, that at the interior would be 4,070,000 atmospheres, — this latter maximum pressure being reached at a depth of 139 geographical miles below the sun's surface.

The pressure increasing rapidly towards the interior of the sun, permanent gases, such as hydrogen, can exist only in a glowing state in the interior of the sun.

Professor Zöllner shows that the quantity of oxygen and nitrogen, if these gases exist in the sun's atmosphere, must be extremely small compared with that of hydrogen in that stratum where the spectrum of hydrogen becomes continuous, and their pressure consequently would not be indicated by absorption.

The absence of oxygen and nitrogen lines in the solar spectrum may also be accounted for by the slight emissive power of permanent gases as compared with that of vaporized solids.

Professor Zöllner concludes: —

1. The absence of lines in the spectrum of a self-luminous star does not prove the absence of the corresponding bodies.

2. The stratum, in which the reversion of the spectrum takes place, is different for every body, and lies nearer to the centre of a star the greater the density of the vapor and the less the emissive power of the body is.

3. In different stars this stratum, other things being equal, lies the nearer the centre the greater the intensity of gravitation.

4. The distances of the strata of reversion for different bodies from the centre of the star, and from each other, increase with the temperature.

5. The spectra of different stars contain the more lines under

similar circumstances, the less their temperature and the greater their mass is.

6. The great difference of intensity in the dark lines of the spectrum of the sun and other fixed stars depends not only on the differences of absorption, but also on the different depths at which the reversion of the spectra takes place.

M. Borelly, at the Marseilles Observatory, has discovered a new planet (No. 110). Professor Peters, of Hamilton College, has added two new asteroids (the 111 and 112) to the number already enrolled. A new comet was discovered at the observatory of Marseilles, on the 28th of August, by M. Coggin.

Professor Winlock, of the Cambridge Observatory, has had photographs of the sun taken nearly every fair day during the past year. The primary objects in this work have been to prepare and perfect apparatus and processes which might be used with the best result during the coming transit of Venus, in 1874. A reliable record of changes in the sun's surface is also obtained by these photographs.

Mr. Proctor has published some novel views of the constitution of the stellar system under the title of "Star Drift" and "Star Mist."

Dr. Gould, with assistants, is now stationed at Cordova, in the Argentine Confederation, having the observatory there under his charge. He proposes to extend the catalogue of the southern heavens beyond the limit of 30°, to which the zones of Argelander extended. Dr. Gould says, "My hope and aim is to begin a few degrees north of Argelander's southern limit, say at 26° or 27°, and to carry southward a system of zone observations to some declination beyond Gilliss' northern limit, thus rendering comparisons easy with both these other labors, and permitting the easy determination of the corrections needful for reducing positions of any one of these three series to corresponding ones for the other."

Great preparations were made to observe the total eclipse of the sun in December, Professor Pierce, of Harvard College, in his official capacity as superintendent of the coast survey, having general charge of the American expedition.

After crossing the Atlantic Ocean, the shadow of the moon passed across the south of Portugal and the Straits of Gibraltar to Algeria, reaching its most southerly limits in about longitude 4° east of Greenwich, where the southern boundary of the shadow-path was in about 34⅔° north latitude. Thence the shadow passed to Sicily, the northern limit passing slightly to the north of Mount Etna, and so, touching the extreme southern point of the Italian peninsula, by the south of Turkey, past Thessaly. The most important parts of the shadow's path were those across the south of Portugal and Spain, in Algeria, and across Sicily. The chief towns which lie close to the central line are Odemira, Silves, Almodorar, Tavira, Ayamonte, Huelva, Palos, Jeres, Cadiz, San Fernando, Arcos, Estepona, and Marbella in the Spanish peninsula; Oran and Ratna in Africa; and Syracuse in Sicily.

The following letter from Professor Young, on the observations at Jeres, Spain, appeared in the New York Tribune: —

"By the courtesy of Professor Winlock I am permitted to communicate the general results of our observations on the eclipse. I think I may say that on the whole our expedition has been highly successful, though more might have been accomplished had the weather been better. We seem, however, to have been more favored in this respect than any of the English parties observing in Spain. From those in Algeria and Sicily I have not yet heard.

"The day and night previous to the eclipse were very fine, but early in the morning it clouded over, and when we arose the prospect was very gloomy. It even rained from time to time. We made all our observations, however, and before first contact (10.25 A.M., local time) there were many patches of partly clear sky, but there was always, even when clearest, enough haze of frost crystals to cause the sun to be surrounded by a conspicuous halo of 22½° radius. At the time of first contact, it was clear enough to allow good observations to be made in the usual method. I attempted to use the spectroscope upon it in the same manner as last year, but failed on account of the thin cloud which most of the time entirely obliterated the chromosphere lines.

"Between time of the first contact and totality, there were several intervals of moderate clearness, in which photographs of the partial phases were taken. Just before totality the clouds became much thicker, and we nearly gave up hope; but at the needed time, almost by the direct interposition of Providence, as it would seem, a small rift in the now heavy clouds passed over the sun, and permitted us to observe the sublime phenomenon, if not in all the beauty and sublimity of last year, yet satisfactorily and most gratefully. Within five minutes after the end of totality the sky was wholly clouded, and we did not see the sun again until near evening, after a heavy storm of wind and rain. During the totality, one good photograph of the corona was obtained with the 6-inch glass, with an exposure of 1½ minutes. It is, of course, by no means so good as it would have been had the sky been truly clear; but it shows a great deal of detail, curved filaments and radial shadings far better than ever before obtained. The picture produced with the 8-inch glass was injured by not being removed until the sun came out. No attempts were made to photograph the prominences, which can be seen and studied at any time. All efforts were concentrated on the corona.

"In respect to the polarization observations, there is reason to suppose that there must have been some peculiar defect in the particular instrument Professor Pickering used last year, as his assistant, Mr. Ross, using it on this occasion, obtained the same unsatisfactory result. But apparently similar instruments, used this year, together with others quite different in construction, indicated radial polarization of the corona. The appearances in the instruments were much complicated by the cloud and haze, but I believe Professor Pickering and Professor Langley both agree that the corona certainly has a considerable proportion of its light radially polarized. Our spectroscopic results completely confirm those of last year, and except that the two faint lines which I saw between D and E last year, and suspected to be corona lines as well as 1474, were not seen at all this time; 1474 was traced by Professor Winlock to a distance of nearly 20 minutes from the sun's limb. I traced it 16 minutes on the west, 12 on the north, 14 on the east, and about 10 on the south. The principal chromosphere lines were also visible in the corona to a distance of 3 or 4 minutes. Professor Winlock and myself both agree in attributing this to the reflection of the haze around the sun. I am more confident as to this, because last year, in a clear atmosphere, the C line was certainly sharply terminated at the upper limit of the chromosphere or prominences under observation. Mr. Abbay, in his spectroscope, saw only the 1474 line and the F line, — the former was considerably the brighter of the two. He saw no continuous spectrum.

"But the most interesting spectroscopic observation of the eclipse appears to me to be the ascertaining at the base of the chromosphere, and, of course, in immediate contact with the photosphere, of a thin layer in whose spectrum the dark lines of the ordinary solar spectrum are all reversed. Just previous to totality I had carefully adjusted the slit tangential to the sun's limb at the point where the second contact would take place, and was watching the gradual brightening of 1474, and the magnesium lines. As the crescent grew narrower, I noticed a fading out, so to speak, of all the dark lines in the field of view, but was not at all prepared for the beautiful phenomenon which presented itself when the moon finally covered the whole photosphere. Then the whole field was at once filled with brilliant lines, which suddenly flashed into brightness, and then gradually faded away until, in less than 2 seconds, nothing remained but the lines I had been watching. The slit was very close, and the definition perfect. Of course I cannot positively assert that all the bright lines held exactly the same position that had been occupied by dark ones previously, but I feel very sure of it, as I particularly noticed several groups, and the whole arrangement and relative intensity of the lens struck me as perfectly familiar. Mr. Pye saw the same thing, for an instant only. Professor Winlock did not, as his telescope at the time, in accordance with his directions, was pointed to a spot at some distance from the sun's limb; neither did Mr. Abbay see it.

"This observation is a confirmation of Secchi's continuous spectrum at the edge of the sun, and, I think, tends to make tenable the original theory of Kirchoff as to the constitution of the sun, and the origin of the dark lines in the ordinary solar spectrum."

General E. Abbott, in a letter to Professor J. E. Hilgard, states, "We have settled that the corona, in part, at least, is solar. The light is strongly polarized in radial planes."

Professor Peirce says, in a letter, "that the true corona is proved to be a solar atmosphere, extending about 80 miles above the visible surface of the sun, there being three different sources of proof of this."

Lockyer, in his report,. in "Nature," of January 19, asserts that the corona is a compound phenomena, arising some 5′ or 6′ high around the moon, with a light beyond, which different observers have noted differently, now stellate with many rays; now stellate with few; now absolutely at rest; now revolving rapidly.

From the spectroscopic observations, Lockyer thinks that the chromosphere may be built up of the following layers, which are in the order of vapor density in the case of known elements: —

×′ (new element),		green coronal line
Hydrogen	Sub-incandescent,	F
	Incandescent,	C, F, near G, h
× (new element),		near D
Magnesium,		b, and lines in blue and violet
Sodium,		D
Barium,		several lines
Iron, etc.,		several lines, including E

He further says: "The foregoing table excludes naturally the substance or substances which give bright lines in the solar spectrum, which are visible at times in the spectrum of the chromosphere. I have ventured to suggest that the substance which gives the line in the green is a new element, because invariably I have found that in solar storms the atmospheric layers are thrown up in the order of vapor density, and because all the heavier vapors are at or below the level of the photosphere itself"

"Parties in Sicily obtained evidence that the corona was radially polarized. Hence the corona not only radiates, but reflects solar heat to us."

Lockyer offers as suggestions: —

"1. The solar chromosphere extends some 5′ or 6′ from the sun (Watson and others), its last layers consisting of cool hydrogen (Mr. Abbay), and possibly a new element with a green line in its spectrum (Young, Barton, and others); which line, if it be identical with the auroral line, as stated by Gould, may possibly be present in the higher regions of our own atmosphere.

"2. Outside this stratum the rays, etc., are for the most part due partly to our own atmosphere, partly to our eyes, for their shape varies; they are seen by some at rest, by others in motion, and their spectrum is the same as that of the dark-moon (Maclear).

"3. The white light of the chromosphere above the prominences, as seen in an eclipse, is due to its strong reflection of solar light, as shown by the polariscopic observations (Ranyard, Peirce, Jun., Ladd).

"4. The rosy tinge of the corona proper, that is, of the region more than 5′ or 6′ from the sun, is due to our atmosphere containing light which comes from both the higher and lower strata of the chromosphere (Peirce, Sen., Maclear, Abbay)."

Professor Winlock found a faint, continuous spectrum without dark lines.

1474, Kirchoff, was found all round the sun to a distance of 20′

from the disc, and appeared to be the most conspicuous corona line.

Professor Winlock also states the probable existence of an envelope surrounding the photosphere, and beneath the chromosphere, of a thickness from 2 to 3 seconds of arc, which gives a discontinuous spectrum of all the ordinary lines, — bright on dark fields.

Professor Pickering, observing with an Arago polariscope, one of the four employed by Prazmowski and Savart, obtained with all three results pointing to a radial polarization of the corona. The light covering the moon's disc he observed to be polarized throughout in the same plane, and the observations showed that the Arago and other polariscopes dependent on color were sufficiently delicate to determine this plane with accuracy.

A writer in "Cosmos," of July 30th, sums up the progress of geography for 1869–1870. We give the following abstract: —

Each year the space of unknown lands on the surface of the globe grows smaller; but the investigations relative to different branches of geography embrace an immense field.

The completion of the Suez Canal and the Pacific Railroad open extended ways for scientific exploration.

Africa and the regions of the North attract, at present, the principal attention of geographers. In Africa, the Abyssinian war has brought out many treatises upon this particular region. An Italian scientific expedition at the present moment is engaged there.

A German traveller, to whom we owe interesting studies upon the shores of the Red Sea, has also explored the bordering regions of Nubia in the country of the Djours, where he is occupied principally with ethnographic researches.

Dr. Schweinfurth, after a long residence among the Africans, confirms the opinions of M. de Quatrefages, that the coloration of the skin cannot serve for the distinction of different races.

In the region of the great lakes of Equatorial Africa, Livingstone pursues his discoveries with a courage not abated by obstacles.

May 30, 1869, at Ujiji, he was preparing to trace a new lake at the west of Tanganyika, from which flows a great river, it may be one of the sources of the Nile, which thus finds itself again reported more to the south. In the south-east there are the travels of Erskine upon the borders of Limpopo, those of Fritsch, of Mauch, which have given hopes of rich auriferous deposits in the interior of *Zambèze*, but the difficult courses of which have profited more to geography than to the seekers of gold. We have had recently an account of the expedition of Lieutenant Aymes, of the French marine, in the basin of *l'Ogové* from the side of Gabon, which has contributed some precious materials for natural history.

Gérard Rohlfs has visited the oasis of Cyrenaique.

Wallace has published an article upon the Malay Archipelago; Dr. Sempor upon New Guinea; Professor Bastion upon Singapore, Batavia, and Manilla; and M. Garnier, a memoir upon the migrations of the Polynesians, published in the Bulletin of the Geographical Society.

In regard to Asia, attention is called to the works of M. Herman de Schlagintweit upon India; of M. Charles Lemire, upon Cochin China, and of M. Francis Garnier, upon the French expedition to Mekong.

In China, Cooper has pushed his explorations into the heart of the empire in the basin of the Yang-tse-kiang; while another traveller, M. de Richoffen, occupied himself with geological researches upon the frontiers of the north beyond the great wall; and a French missionary, P. Armand David, has employed the leisure hours of his office in the study of the natural history of Thibet and Mongolia.

Upon the confines of Siberia the Russians have finally fixed the limits between their Asiatic possessions and China; at the same time they continue their explorations into Central Asia, as much from the political point of view as in the interests of science. Those desiring ampler details of the progress in geography will find them in the report made by M. Charles Mannoir to the Geographical Society, or in the selections of the "L'Année Geographique" of M. Vivien de Saint Martin.

In Central America the piercing of the Isthmus occupies public attention. Malte-Brun enumerates no less than 28 projects for a canal across the isthmus. To these different projects it is necessary to add those of M. du Puydt, and of Commander Selfridge, who commands the latest expedition to explore the routes. In expectation of the realization of these projects, the government of Honduras has ordered the construction of a railroad setting out from the port of Puerto-Cabello, upon the Atlantic, and ending in the Bay of Fonseca, upon the Pacific. These important works are indicated because they will have an important bearing upon many branches of geography.

Attention is also called to the publication of Poncel, upon the Argentine Republic; the researches of Agassiz upon the Amazon; the geological studies of M. Guillemin Taragre, in Mexico, and the expedition of Whymper, in Alaska.

Moyne has made a visit to the Strait of Magellan, and to the country of the Patagonians.

In Australia one signals the expedition of John Forrest into the interior of the eastern part of the continent as far as 123° of east longitude from Greenwich. The report published by the governor of the State of Victoria, under the title of "Auriferous Deposits and Mining Districts of the Province of Victoria," by Mr. Brough Smith, is also cited upon this region.

Proceeding eastward from the Sea of Aral, the Russians have rendered the river Syr Daria navigable by steam vessels of a limited size, and, fixing military posts on its banks, have ascended towards its sources, and taken possession of the populous and flourishing city of Tashkent, a great mart of caravan commerce. Russia has also triumphed over the Khan of Bokhara. The apprehension that these advances of Russia would prove prejudicial to British India is losing ground in England.

The industrial classes of the United States have been the subject of a long and interesting report by Mr. Francis Clare Ford, Secretary of the English legation, at Washington. This report was made in pursuance of a circular addressed by Lord Clarendon, in April, 1869, to the diplomatic and consular agents of Great Britain, instructing them to report upon the condition of the industrial classes in the countries to which they were accredited. Mr. Ford says that the American system of common-school education has elevated the condition of the native-born working man, and has disposed him to prefer occupations in which the exercise of the brain is in greater demand than that of the elbow, and asserts that the steady influx of immigrants for the last twenty years has created a disinclination on the part of American workmen to engage in the rough toil of purely muscular labor which the newly arrived foreigner is ready to exert for his support.

It will be recollected that in the "Annual of Scientific Discovery" of 1870, we noticed the enactment passed by the Massachusetts Legislature to provide instruction to the working-classes in mechanical drawing. Several of these schools are now in operation, and constitute, we think, the germ of a brighter future.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

MECHANICAL STOKING.

THE following interesting paper was read, at the meeting of the British Association, in Section G (Mechanical Science), by Mr. James Smith, of Messrs. T. & T. Vicars, engineers, Seel Street, Liverpool: —

"Our reasons and apology for bringing under your notice the subject of mechanical stoking are, first, the importance to the mechanical engineer of everything that relates to furnace management, and especially the importance of any improvement that will enable him to have the slavish labor of stoking performed by a machine that will more efficiently discharge the required duty than human labor can; and this, I conceive, is always the case when a machine is successfully applied to any purpose. Secondly, the visit of your society to our town enables us to submit to the judgment of a competent tribunal the merits or defects of a system of mechanical stoking that we have applied and are applying largely in different parts of the country. All who have had any experience in furnace management are aware that the duty obtained from a boiler or other furnace depends to a very great extent on judicious stoking, and one of the troubles of the practical engineer is to obtain the services of stokers upon whom he can rely. Several writers on the subject have directed attention to the desirability of substituting mechanical for hand stoking as the only means of securing economy, efficiency, and smokelessness. Bourne, in his work on recent improvements in the steam engine, published last year, says: 'In steam vessels it is most desirable that some proper species of firing apparatus should be employed, as the labor and difficulty of firing large furnaces at sea, especially in hot climates, is very great. I believe that a good smokeless furnace and a good self-feeding furnace will come *together*.' *Considering* the acknowledged importance of the subject, it does seem remarkable that so little has been done in this direction. Of the different fire-feeding machines, as they have been called, that have been employed at different times, I think I am correct in stating that, excepting the one I wish to bring under your notice, Juckes' Endless Chain Grate is the only one that has received any considerable amount of approval. Of the performance of this furnace very conflicting accounts are given; but I believe that under favorable conditions as to fuel, management, and work to be done, when applied to externally fired boilers the performance of this furnace has been found satisfactory. Although the Juckes' grate does, under favorable circumstances, prove the superiority of mechanical over hand stoking, yet it does not, I think, sufficiently meet the engineering requirements of the present time; it has one serious defect: it is only applicable to externally fired boilers, and is very cumbrous. Before describing particularly our furnace, I will speak of what I conceive ought to be aimed at in constructing a mechanical stoker.

"The late Mr. Charles Wye Williams, who has done so much to diffuse and popularize correct views on the subject of furnace management, writes, in his work on the combustion of coal and the prevention of smoke: 'The facility with which the stoker is enabled to counteract the best arrangements naturally suggests the advantage of mechanical feeders. Here is a direction in which mechanical skill may be successfully employed; the basis of success, however, should be a sustaining at all times the uniform and sufficient depth of fuel on the bars.' This is correct so far as it goes, but a mechanical stoker, to be successful, must do more than this: it must preserve the air spaces of the fire grate uniformly open, be self-cleansing by discharging the ashes, slag, or clinker as formed; and, in addition, I think it is important that the fuel should be introduced at the front of the furnace, and should have a progressive motion towards the bridge. The advantage of introducing the fuel at this part, as a means of insuring economy and preventing smoke where bituminous fuel is used, has been proved conclusively by numerous experiments. I suppose the cause of this is the long run of the volatile hydrocarbons over the incandescent fuel that fills the bridge part of the furnace. It is also important that the machine stoker should be easily regulated and controlled for the purpose of adjusting the supply of fuel to the work to be done, and that it should be very little liable to derangement, or wear and tear. I think our apparatus fulfils all these conditions. Like all fire-feeding machines, it is provided with a hopper or fuel receptacle; the fuel is forced into the furnace by two plungers or pushers (having an alternate motion) at a level of about 6 inches above the bars. In very wide furnaces we use 3 plungers, and the shaft that works the plungers is moved by a ratchet. A very simple arrangement enables the attendant to vary the rate of feed by causing the diving eccentric at each stroke to take a lesser or greater number of teeth. Progressive motion is given to the fire by causing the bars *to move forward en masse,* and bringing them back in detail. The cleansing of the bars is also effected by this motion: the bars have a stroke of about 3 inches, and we find in the average of cases that a complete stroke about every 2 minutes is sufficient to give the progressive motion necessary to maintain a proper thickness of fire. As the bars themselves form an important part of the machine, we have found it necessary to make special provision for their preservation. Each movable bar is provided with a trough containing water, and there is a centre rib cast on each bar which is immersed in the water. The other part of the bar forms a perfect cover for the trough to exclude ashes, etc.; these troughs are supplied with water from a small cistern, and the level is maintained by a very sensitive float and valve. In consequence of the slow motion of the machine, very little wear and tear occurs in the working parts. There is no part of the apparatus exposed to any injurious action of fire except the upper surface of the bars, and these are effectually protected by the trough arrangement. Our experience shows that with moderate care the amount of wear and tear is not greater than what occurs in most ordinary furnaces.

"With regard to the economical results obtained, you will find some particulars given in our circular. As compared with the best hand-firing, where ordinary fuel is used, the results do not exceed 10 to 12 per cent. We find that the system adopted by the careful stoker and the machine system are very similar. In both cases frequent charges at short intervals are adopted instead of heavy charges at longer intervals; but, in the case of hand-firing, the incessant opening of the doors, and the interruptions caused by cleaning the bars, are drawbacks that are avoided in the machine. Of course, when the machine is compared with ordinary random hand-firing, its economical superiority is very decided; but the chief source of economy arises from our being able to use the smallest and cheapest fuel, — fuel much of which cannot be used at all in ordinary hand-fire furnaces. The saving from this cause varies in different districts, and will range from 20 to 100 per cent. In most cases, perhaps, the appreciation that leads to the adoption of any machine or system is the most satisfactory evidence of its value; yet this is not a rule without numerous exceptions, and on no subject is there more reasonable ground for a justifiable scepticism as to the merits of any remedy that may be propounded than that of smoke prevention. For many years the public have had plans constantly brought under their notice that were to end the nuisance arising from smoke, but it still continues a very substantial nuisance, and appears to have a very wonderful vitality. As evidence of approval of the furnace, I may state that since we commenced manufacturing this form of furnace, about 18 months ago, we have fixed and put to work more than 120, with the most satisfactory results, and approval of the furnace is extending. We are at present sending out more than 20 per month; in the town of Bradford alone, which appears to be taking the lead in the enforcement of sanitary improvements we have orders for between 50 and 60 furnaces in a single *street or road*, Thornton Road.

"To prevent misapprehension it is as well to state that we have been, for a period of 5 or 6 years, engaged perseveringly in efforts to perfect mechanical stoking, but our first attempts were only partially successful. Our first grate was a modified Juckes; but we soon found the wear and tear so considerable that we had to turn our attention to discover some means of remedying these very serious defects, and for more than 3 years we were engaged in extensive experiments involving much thought and money expenditure. The result is the machine I have the honor to bring under your notice."

Mr. Lavington E. Fletcher, C.E., said he had witnessed some very carefully conducted trials with this apparatus used against careful hand-firing, and the results were very satisfactory. The chairman said there was no doubt that mechanical stoking must be superior to hand stoking. Such an apparatus as had been described by Mr. Smith was wanted, and it was only a question of cost. Mr. Smith then thanked the chairman and gentlemen for their attention, and said he would be glad to show any gentleman the furnace at work who would favor Messrs. Vicars with a visit to their works, Seel Street, Liverpool.

EFFICIENCY OF FURNACES AND MECHANICAL FIRING.

Having for some time past given a large share of my attention to the subject of the efficiency of furnaces, I have to bring before you a few results of my experience in this most interesting and important inquiry.

Since the time in which Wye Williams lived and labored, Professor Tyndall and Dr. Frankland have shown that the energy of combustion is within wide limits independent of the density of the air, the natural inference *at first sight* being that in furnaces the temperature of the air does not affect the efficiency. One of Wye Williams' well-known experiments was to introduce a bent plate perforated with 56 half-inch holes into the centre of a furnace where one or two bars had been removed for its reception. "Adequate mixture," says Mr. Williams, "was thus instantly obtained, as in the argand gas-burner; the appearance, as viewed through the sight-holes at the end of the boiler, being even brilliant, and as if streams of flame instead of streams of air had issued from the numerous orifices. It is needless to add that nowhere could a cooling effect be produced, notwithstanding the great volume of air introduced."

Now I cannot at present do more than state the simple fact that I have tried similar arrangements in many different instances and under several different conditions, and that I have rarely failed to produce a cooling effect. The arrangement by which the results have been arrived at may be thus described: A few of the ordinary fire-bars are removed from the centre of the flue. A pair of longitudinal bearers about 6 inches apart are then introduced, their upper surfaces being level with the common fire-bars. On these bearers are placed small arched transverse bars, *each about 1 inch* thick, in contact with one another. Semi-circular holes are cast in the transverse surface of these bars, so that when placed together on the bearers they present the appearance of a tunnel about 9 inches high pierced with numerous small holes, an arrangement not differing widely from that of Wye Williams, except that the tunnel, being of loose cast-iron pieces, is no more liable to deterioration by heat than common fire-bars. If the mere fact of admitting air to the hydrocarbons at the moment of their generation, and in minutely divided lines, is sufficient to insure their combustion, surely nothing could do so more effectually than this arrangement. But the result.

A large quantity of fuel being placed upon the incandescent carbon in the furnace, we have, after the expiration of a few seconds, a splendid display of white flame, not entirely smokeless, but comparatively smokeless, unless the quantity of air admitted is very large; white flame and intense heat, — evidence of the precipitation of the carbon particles and of their combustion after precipitation; smoke-burning, — not smoke-prevention; greatly increased temperature of the furnace-door, — evidence of increased radiation of heat. But, as I said before, in almost all cases a loss of efficiency in the furnace, — a reduction in the absolute temperature of the flame. Was Mr. Williams deceived by that radiant heat? I cannot avoid the conclusion that he was in some cases at least. But the furnaces adopted with economical results contained elements not yet described. The ash-pit was divided into 3 chambers by 2 vertical sheet-iron partitions, made fast to the longitudinal bearers in such a manner that all air entering it at the central chamber must pass through the arched bars, while that entering by the two side chambers reaches the fuel in the ordinary manner. Now, observe the difference: Here we have a long central fire-chamber open to the air only at one end. The air before entering the fire-chamber passes over the surface of highly heated sheets of iron, traverses in turn the cross-pieces of the little arched bars and the heated surface of the ribs. Even with this simple change the results are, I believe, in all cases, altered from failure to success. A heating effect has been obtained where a cooling effect only could be produced before.

To sum up my own observations on this subject, I find: (1.) That the admission of cold air in quantities sufficient for the complete combustion of the gases in ordinary furnaces is attended with a loss of efficiency in all cases, even if that admission takes place in finely divided streams immediately over every portion of the fuel from which the gases are rising. Radiant heat, and consequent temperature of the furnace door, are enormously increased; smoke, however, is considerably reduced. (2.) That by the comparatively slow motion of air over heated surfaces, and its consequent rarefaction and increase of velocity when issuing from the orifices of the arched bars, a much more perfect chemical union is insured. The flame is not so luminous, but a higher rate of efficiency is obtained. Radiant heat is decreased, the furnace door is rendered less hot, and smoke is more perfectly prevented. The old Cornish system of dead-plate firing, when conducted *very carefully*, and in such a manner that the incandescent fuel at the back of the furnace is never allowed to burn into holes, has, as we all know, certain advantages. But when the back of the furnace is left to itself, I believe it to be a most difficult matter to avoid the admission of cold air *en masse*, — a condition which cannot but be attended with loss of efficiency; and in my attempts to discover the best method of mechanical firing, I could not find that those systems in which the coal had a progressive motion from the front to the back were free from these defects. Such methods appear to me to owe their advantages, for no doubt they have advantages, to other causes than that of the perfect combustion of the hydrocarbons; and is not the comparative freedom from smoke in this system of firing the result, in a great measure, of that union of carbon from the front with carbonic acid from the back, producing carbonic oxide, and inevitable loss of heat, — the pernicious principle resorted to by a whole army of smoke-burning patentees? The apparatus which appears to me most correct in principle does not profess to compete with the more perfect mechanical stokers, inasmuch as the clinkers are removed by the firemen in the ordinary manner. In short, since my attention was drawn to the subject, I have come to the conclusion that the principle of what was probably the first attempt ever made in mechanical firing — I speak of Stanley's patent — is capable of the highest possible efficiency. Twenty years ago nearly every furnace in Lancashire was fed by the apparatus popularly known as the "hopper." In a box on the front of each furnace 2 fans revolved horizontally. Fuel was drawn from a hopper by rollers which crushed and let it fall on to the 2 fans, which in their turn propelled it into the furnace. It was possible to adjust the speed in such a manner that the fuel was spread uniformly over the whole surface of the bars. I would merely add that when the 2-flued Lancashire boiler replaced the wagon and egg-ended boilers then in use, the hoppers were taken down, possibly in some places applied to the new flue boilers, found not to throw the fuel evenly over the bars, and discarded. In Leeds, however, they are still in use to a considerable extent, probably because some makers there took the trouble to adjust them to their altered circumstances. For a single 2-flued boiler the hopper, as now in use at Leeds, requires about 20 toothed wheels, and at least 2 worms to drive the crushers and other portions; and notwithstanding the fact that the teeth of those wheels are constantly breaking, and that the whole apparatus trembles under the sudden check caused by a large lump of coal falling between the small crushing rollers, manufacturers who have tried it for so many years give universal testimony as to its economy. I understand that one engineer in Leeds still makes a considerable number of them. This apparatus does not, of course, prevent smoke, but it distributes the smoke from a given quantity of fuel over a longer period than in hand-firing, and reduces its blackness in the same proportion.

Now, does it not appear that if we can retain the manner of throwing on the fuel, very considerably simplify the means, and *use it in conjunction* with the fire-bar arrangement already described, we shall have a very efficient furnace and a perfect preventer of smoke? The 20 toothed wheels and 2 worms have been reduced to 1 worm and wheel; the 2 hoppers (one over each flue) to 1 hopper in the middle of the boiler face. The crushing rollers have been done away with altogether, and an arrangement substituted which crushes and metres the fuel as effectually but much less suddenly. Through the fuel in the middle of the hopper passes a cast-iron screw, with a tapering helix of small diameter at the centre, but increasing gradually up to the internal diameter of its containing cylinder outside the hopper. The 2 halves of this screw are right and left handed, respectively. It has a slow revolving motion, and its action on the coal contained in the hopper is evidently of a nibbling kind, while it metes out to the fans of each flue the desired quantity of fuel. There are other details which have not been overlooked, such as the well-known heaping up of the coal on the dead-plate, the cause of which has been entirely removed. And last, but not least, the whole machine is fixed to a frame made fast to the boiler, by 3 bolts through the shell, no holes whatever being cut in the boiler face. The fires made by this apparatus are perfectly level, and are absolutely free from even light smoke.

I hold in my hand a report prepared about 4 months ago, on the efficiency of the apparatus in question. It is founded on very carefully made evaporative experiments, the conclusion being that the feeder, when used for the first time in competition with the best hand-firing that could be obtained, gave an increased efficiency of 9.696 per cent. over and above the efficiency already attained with the argand furnace alone. The cost of the combined apparatus is, of course, much lower than that of any of the more elaborate mechanical stokers, — little more than one-half; but I believe the efficiency is higher. — *C. E. Deacon, British Association.*

MANUFACTURE OF RUSSIA SHEET IRON.

Herbert Barry, Esq., late director of estates and iron works of Vuicksa, thus describes the manufacture of sheet iron in Russia: —

"The refined iron is hammered under the tilt-hammer into narrow slabs, calculated to produce a sheet of finished iron 2 archimes by 1 (56 inches by 28 inches), weighing when finished from 6 to 12 pounds. These slabs are called *balvanky*. They are put in the reheating furnace, heated to a red heat, and rolled down in 3 operations to something like a sheet, the rolls being screwed tighter as the surface gets thinner. This must be subsequently hammered to reduce its thickness and to receive the *glance*. A number of these sheets having been again heated to a red heat, have charcoal, pounded to as impalpable a powder as possible, shaken between them through the bottom of a linen bag. The pile then receiving covering and a bottom in shape of a sheet of thicker iron, is placed under a heavy hammer; the bundle, grasped with tongs by two men, is pocked backwards and forwards by the gang, so that every part may be well hammered. So soon as the redness goes off they are finished, so far as this part of the operation goes. So far they have received some of the *glance*, or necessary polish; they are again heated, and treated differently in this respect, that instead of having powdered charcoal strewed between them, each two red-hot sheets have a cold finished sheet put between them; they are again hammered, and, after this process, are finished as far as thickness and *glance* go.

"Thrown down separately to cool, they are taken to the shears, placed on a frame of the regulation size, and trimmed. Each sheet is then weighed, and, after being thus assorted in weights, they are finally sorted into first, second, and thirds, according to their *glance* and freedom from flaws and spots. A first-class sheet must be like a mirror, without a spot in it.

"100 poods of *balvanky* make 70 pounds of finished sheets; but this allowance for waste is far too large, and might easily be reduced. 4 heats are required to finish.

"The general weight per sheet is from 6 to 12 pounds, the larger demand being from 10 to 11 pounds, but they are made weighing as much as 30 pounds, and may then almost be called thin boiler plates, being used for stoves, etc. Besides the finished sheets, a quantity of what are called *red sheets* are made, which are not polished, and do not undergo the last operation.

"Taking the Michælofskoi Works, which are the largest sheet-iron ones in the empire, I found that the power running the sheet rolls was equivalent to 40 horses, the rolls making 70 to 80 revolutions a minute. The hammers used are powerful, having the surface of the stroke very large, — just the contrary shape there to the ordinary tilt-hammer. A gang turns out in a shift from 450 to 500 sheets.

"In the Central Works, where they make sheet iron from puddled iron, they *roll* it into the necessary size, and then roll this *balvanky* into half-ready sheets with the same sort of rolls as are used in the North, but which, however, run much slower; the finish being given also by hammers in the same manner, but leaving out the final part of the operation of placing cold finished sheets between the hot unfinished ones. The hammers are not so heavy, and the heating furnaces are not so well constructed and do not regulate the flame as well. The trimming, sorting, etc., are carried out in just the same way.

"The waste is really greater in the Central Works than it *should* be in the North, as the hammered iron does not leave such a raw edge as the puddled.

"A fact that proves the superior manufacture of the North over the north parts of the empire is, that whereas in the former sheet iron is the best paying, in the latter it is the worst business. . . .

"For the uses to which sheet iron is put ductility is of the first consequence, and no sheet iron is of passable quality that *that will not bend* 4 times without breaking; some made in the

Oural I have bent as many as 9 times without showing the break. Coupled with this quality the *glance* must be taken into consideration, as good polished iron will not take so much paint as the inferior polished." — *Bulletin of the American Iron and Steel Association.*

COAL AND SMOKE CONSUMPTION.

On the Pennsylvania Railroad, experiments are now being made, says the "Chicago Railroad Review," with an apparatus for bituminous coal invented by J. T. Rich, of Philadelphia, who puts into the fire-box a "dead-plate" extending from side to side, sloping from a short distance beneath the door and then turning down perpendicularly to the grate bars. Above is a fire-brick arch extending from the back well forward, around which the ascending flame must pass towards the front. Outside the door is a hopper, constantly supplied with coal, which passes in, as that already in the fire-box works down to the dead-plate. A fire being started in the grate, cokes the coal on the dead-plate; and the heat is utilized by passing around the arch and through the flues. As the coke, thus made, burns away, its heat and gases, without smoke, passing through the flues, new coal constantly works down and undergoes the same process. The experiment thus far shows there is no doubt that the process will result in almost entire freedom from smoke; but the practical question, whether steam can be made fast enough, is not yet decided. — *Journal Franklin Institute.*

AERO-STEAM ENGINES.

The advocates, says the "Engineering," of what is known here as the Warsop system claim that the application of that system to a boiler and engine prevents the formation of incrustation, does away with priming, and effects a considerable economy of fuel. Now we have no wish to deny that under certain circumstances results have been obtained which appear to warrant the above claims, *in those particular cases;* but what we object to is, that these results should be made the foundation of totally fallacious arguments as to the value of the "aero-steam" system of working. It may be that the injection of heated air into a boiler is, under certain circumstances, a good way of promoting the circulation in that boiler, and thus preventing the evils by which a want of proper circulation is attended; but it by no means follows from this that the injection of air is the best way of producing circulation under all circumstances. On the contrary, until we have clear evidence afforded to us that the injection of air so far improves the economic evaporation of, not a bad, but a thoroughly good boiler, as to more than repay the cost of forcing in that air, we shall regard the system merely as a means of counteracting faults of construction which should not have any existence.

As with the boiler so with the engines. Non-condensing engines having unjacketed cylinders, supplied with steam at from 40 pounds to 50 pounds per square inch, and worked with but little expansion, have in certain cases showed more economical results when worked with a mixture of steam and air than when worked with steam alone in the ordinary way. But we submit that such engines — although we regret to say that large numbers of them exist — are not fair examples of steam machinery, and that the credit to be derived from beating them in economy is but very small. Given an engine consuming say 8 pounds or 10 pounds of coal per indicated horse-power per hour, and the difficulty of making such alterations as will produce a more economical result is not great. If the aero-steam engine is to take a high position in the future, it must do far more than this; it must be proved to be more economical both as regards fuel and maintenance than steam engines of thoroughly good construction, such as are turned out by our leading makers; and at present we have but small hope that any such proof will be forthcoming. In making this assertion, we have no wish to discourage Mr. Warsop, Mr. Parker, or others, who, like them, are experimenting on the use of steam and air in combination; but what we desire to point out is, that they would save themselves much useless present labor and expense, and future disappointment, if, instead of contenting themselves with beating indifferent steam engines, they would ascertain carefully and without prejudice just what their respective systems can or cannot effect under the best condition under which they can be applied. Engineers well know that for a certain sum of money a steam engine can be constructed to develop a certain power with a certain consumption of fuel. Let it be proved that by the adoption of the "aero-steam" system there can be constructed for the same sum an engine developing a greater power with the same consumption of fuel, or the same power with a less consumption of fuel, and without any increased cost for maintenance, and the value of mixed steam and air engines will be established. — *Scientific American.*

THE FRICTION OF STEAM ENGINES.

If we did not believe that it is easy to say something new on a subject which has been in a very peculiar sense worn threadbare by the inventors of cylinder lubricators and steam greasers, this article would never have been written. So far as we are aware, all the information regarding the resistance of steam engines due to friction is to be found in the circulars of inventors, one or two papers read before engineering societies by the advocates of particular methods of lubricating engines, certain theoretical disquisitions contained in text-books of mechanical science, and perhaps a report or two in the "Journal of the Royal Agricultural Society." It is almost needless to say that the subject is one of very considerable importance; but it may be worth while to bring this importance home in a tangible form to the employer of steam power. It may be stated, in pursuance of this object, that it by no means follows that an engine giving a very high indicated duty per pound of coal is really the most economical that a manufacturer can use, for the simple reason that the power required merely to drive the engine may be so great as to render the saving in fuel valueless. A case in point suggests itself. An experiment was made some time since with a compound engine, the general particulars of which are before us. This engine was of the annular type; the large cylinder about 35 inches' diameter, the inner cylinder about 15 inches, the stroke of both pistons was the same, about 5 feet, the piston rods both laying hold of the same crosshead, which was connected with an overhead beam. The experiment consisted in shutting the steam off from the inner cylinder and driving with the outer annular piston alone. It was found that the engine, then indicating the same horse-power as before, failed to drive the machinery at the proper speed; and it was not till the indicated horse-power was augmented nearly 40 per cent. that the engine would do the work. On permitting the steam to find its way to the inner cylinder as before, the indicated horse-power fell to the original point, the machinery being driven at the proper speed. We shall not pretend to explain why this was the case. It is indeed difficult to understand why the fact that the inner cylinder, though open to the atmosphere, took no steam, should so enormously reduce the effective power of the engine. The facts are as we have broadly stated them, and there is no reason to think they would now want explanation if engineers had in times past devoted a little attention to the study of the phenomena of friction in the steam engine. We have no doubt whatever that many so-called economical engines are doing very bad work indeed, nor that many so-called wasteful engines, as far as coal is concerned, are giving out a far higher duty than is generally believed. The entire subject is wrapped up in mist, — a mist which can only be dispelled by careful experiments, extending over long periods, and properly and fairly analyzed. That a few engineers have conducted experiments on the friction of steam engines and other machines is certain; but it remains to accumulate in a single volume the statistics which these gentlemen possess, and to put them into a form which may render them generally useful. In pursuance of this object we have for some time past been accumulating data, as yet infinitely far from being complete. But these data have, at all events, done this much, — they have satisfied us that ordinary theories regarding friction in steam engines, based on investigations concerning the coefficients of friction between lubricated surfaces, apply most irregularly and imperfectly. In other words, there is no theory at present in existence which will enable us even approximately to predicate with certainty what the loss of effect by friction in any given engine may be. In certain cases, calculations made with this object will correspond, with surprising exactitude, with the results obtained through the indicator and dynamometer. But the engineer, resting satisfied with such occasional coincidences, is mistaken in his views. In scores of other instances enormous discrepancies will be found to exist between theory and practice, — the almost total absence of frictional resistance in some engines contrasting strangely with the expenditure of power absolutely wasted in others. It is not the mere loss of fuel alone — although that is bad enough — that has to be considered in dealing with this subject. We find engines unable to do their work overloaded and worn out; boilers burned and overtaxed; grease and oil wasted; indeed, we go so far as to hold that every horse-power unnecessarily spent in overcoming the frictional resistance of a steam engine costs three times as much as if it were spent in doing useful work, and this without taking at all into account the fact that useful work returns money, while what we may term the internal work of the steam engine returns none.

The difficulties which lie in the way of ascertaining by actual experiment what the frictional resistance of an engine is are very great, and to this cause no doubt is to be attributed the greater portion of the existing ignorance of the subject. The obstacles in the way are of two kinds. In the first place, it is very difficult to put a dynamometer or brake on large engines, whereby to ascertain their duty; and, in the second place, the amount of friction varies not only in different engines, but in the same engines, in a very extraordinary way. As regards the first difficulty, we can, in the case of pumping engines, ascertain precisely how many foot-pounds of work an engine actually gives out in the shape of useful effect, while the indicator shows the work done on the piston; but from these data it is impossible to calculate engine friction exactly, because our calculations are complicated by the greater or less efficiency of the pumps. It is possible that nothing can be more deceptive than the results obtained from pumping engines, and therefore we have no hesitation in rejecting their aid in dealing with questions of engine friction. Practically speaking the only generally available test is the indicator, used with the engine light and the engine loaded; but diagrams taken thus do not account for the extra friction due to the performance of work, though useful to some extent in their way; but no investigation of the qualities of an engine can be regarded as complete unless the dynamometer is used as well as the indicator.

As regards the variation in the loss by friction in the steam engine, a very great deal might be said which we shall not attempt to say now. It may induce others to experiment for themselves, however, if we place a few facts curiously illustrative of the peculiar phenomena of engine friction before our readers. In one case we conducted the experiment personally; for the results of the other we are indebted to a gentleman who, in superintending the replacement of ordinary boilers by the now well-known Howard boiler, has occasion to indicate a very large number of engines, and on whose accuracy we can rely with certainty. In the first experiment which we shall cite we found the full power exerted by a rolling-mill engine in the north of England, — where, it is unnecessary to specify, — to be 291.5 horse. This included the resistance due to fly weighing 30 tons, a bar-mill with 2 pairs of rolls working on heavy orders, and the requisite gearing. Engine and mill empty required, according to one set of diagrams, 74.8 horse-power to run them at the working speed; but, according to another set of diagrams, the frictional resistance of engine and mill is less than 35 horse-power, and all the diagrams were taken within a few hours. We cite this case only to illustrate the difficulties engineers have to contend with in endeavoring to estimate the friction of engines under ordinary circumstances.

The other experiment is very interesting and curious as regards results. The engine was a double cylinder traction engine, built by Messrs. Howard, of Beckford. The cylinders are 8 inches' diameter and 12¾ inches' stroke. The engine shaft can be disconnected from all the rest of the machinery, so that the whole work done by the steam consists in turning the crank shaft and overcoming the friction of the bearings, pistons, etc. With 60 pounds of steam in the boiler, the engine, making 190 revolutions, indicated unloaded 2.64 horse-power. The engine was then set to drive a brake loaded to 16 horse-power, the link being put in full gear; under these conditions the engine indicated 22.55 horse-power. The frictional resistance was therefore increased, by the fact that the engine was now doing work to 6.55 horse-power, or to nearly 3 times that of the unloaded engine. This is all plain sailing, but now comes a most remarkable fact. The throttle valve was thrown full open, or nearly so, and the engine linked up, — that is, worked expansively at the same velocity, 190 revolutions per minute. The load on the brake, etc., remaining absolutely unaltered, any engineer would predict that, under these circumstances, the result would be the same. Far from this being the case, however, it was now found that, the effective work or duty of the engine being unaltered, the indicated power *was only* 19.86 *horse-power*, so that the friction of the engine when linked up was only 3.86 horse-power, or little more than one-half that of the engine working in full gear. Lest there should be any mistake about this, the brake was then loaded with 504 pounds. With the link in full gear, the engine indicated 44.88 horse-power; the link was then put in the first notch, and the throttle valve fully opened, everything else remaining unchanged, when the power fell to 40.92 horse; the frictional or internal resistance of the engine in the latter case thus being 3.86 horse-power less than in the immediately preceding experiment. How are these facts to be accounted for? Is it that the varying strain on moving surfaces in contact, due to the action of expanding steam, is attended with less frictional resistance than is present when the metals are under the steadier strain of non-expanding steam? We shall not pretend to answer these questions. There are the facts for the consideration of those interested.

Is it too much to hope that engineers, who have the opportunity, will take up this subject and endeavor to throw light into what is at present a very dark and unexplored region of mechanical engineering? We are convinced that the results would, when time and perseverance had multiplied data, be found of very great value to those who desire to see the steam engine undergo the real improvement of which it is still capable.—*Engineer.*

THE FAIRLIE ENGINE.

Mr. Robert Fairlie certainly deserves success, and we have pleasure in believing that he is really commanding it. On two recent occasions in the little "cabbage garden" at Hatcham, another of his great triumphs was exhibited in the trial of the "Tarapaca," a double bogie locomotive of 60 tons' weight, coaled and watered, destined for Peru. The experiments were witnessed by some hundreds of eminent official and scientific men, who were all in accord, in so far as we could hear, in their admiration of the new engine, which for hours in succession performed the feat, smoothly and with perfect success, of turning round the oval in the gardens, the end curves being of only 50 feet radius. The railway world has heard of Mr. Fairlie's "Little Wonder" at work upon the Festiniog Railway, and of the triumphs of the "Progress" on the Brecon and Mertly Railway. The "Tarapaca" may properly be designated the "Great Wonder" in the adaptation of steam-power to locomotive purposes. As stated, the engine is 60 tons' weight in working order, or 40 tons' weight when empty; the bunker-room is sufficient for 30 cwt. of fuel, and the tank accommodation is for 2,200 gallons of water, which should suffice for a 60 miles' run. The weight is equally distributed upon 12 wheels, in 2 groups of 6 each. The wheels in each group are coupled together, so that all the 12 are driving-wheels, and the whole of the 60 tons is thus made available for adhesion. The "Tarapaca" will have to work a gradient of 1 in 26 for 11 miles on the Iquiqui line in Peru, belonging to MM. Montero Frères. The engine has 4 cylinders of 15 inches' diameter and 20 inches' stroke. The wheels are 3 feet 6 inches in diameter, and the brake-arrangement, very powerful, is applied to the 4 inner wheels of the 12. The force of the engine at the rails is about 21,400 pounds, or 9½ tons, on the level, at a speed of 12 miles an hour. The "Little Wonder" runs upon a gauge of 1 foot 11½ inches; the "Tarapaca" is made for the ordinary 4 feet 8½ inches gauge. The Fairlie engine can double the capabilities of any line, irrespective of gauge, its power being double that of engines of the ordinary type. The Festiniog gauge is unduly narrow, and the ordinary 4 feet 8½ inches gauge is wider than is necessary to realize the maximum advantages of the Fairlie system, which may be secured with a gauge of from 3 feet to 3 feet 6 inches. A 3-feet gauge line worked upon this system may be made to carry as many passengers and as many tons of goods as the broadest gauge line in existence, and it can be worked in the ordinary manner, at a speed of from 40 to 45 miles an hour. The dead weight on narrow-gauge lines is much less proportionately than on broad-gauge lines. A wagon for a 3-feet gauge, weighing 1 ton, will carry 3 tons of paying weight. The best form of wagon on a 4 feet 8½-inch gauge weighs from 3 to 5½ tons, and carries from 5 to 10 tons, or about 1.90 ton per ton of wagon.

The average load carried by merchandise wagons, exclusive of coal, is about 10 cwt. paying weight. The load these wagons ought to carry should be from 5 to 7 tons; of paying load they really carry but a twelfth of what they ought to do. If our goods and mineral wagons were only a ton in weight, as they ought to be, they would carry 3 tons of load, or 6 times the average load now taken, and would reduce the dead weight from 4 to 1. A railway company, that we forbear from naming, carries over its line 126,000,000 tons per annum, out of which it takes payment for only 15,000,000 tons of paying load. Fairlie's narrow-gauge and 1-ton wagon system would reduce this gross tonnage one-half, thus saving the company the cost of hauling 60,000,000 tons per annum of dead weight. The experts who attended the trials at Hatcham on the last two days were agreed as to the entire absence of oscillation in the movements of the engine. The ordinary locomotive, it is well known, increases its oscillation as it increases its speed, and ipso facto increases the power and effect of the blows inflicted upon the rails. The oscillations of the engines are communicated to the trains they draw, and danger is thus increased. The Fairlie engine, it has been fully demonstrated, runs more smoothly and faster without the pounding of the rails caused by the engines of the ordinary type. From all that we have seen of Mr. Fairlie's "Big" and "Little Wonders" in his double bogie engines for any gauge, but preferably for a gauge of say 3 feet, we cannot doubt that the adoption of his inventions would revolutionize railway working, and make the difference, as regards railway property, that there is between wasted money and lucrative investments. Ere long, notwithstanding the vis inertiæ of the directorial mind, we have little doubt that we will have English companies sharing with Russian, Peruvian, and Welsh mine masters, in the benefits that Mr. Fairlie and his double bogie system are ready to confer upon them. An engine on the Fairlie principle has recently been completed in the United States, adapted to the roads of that country. It is thus described by the "Springfield Republican:" "The memory of that mythical divinity, the two-faced god, Janus, is perpetuated in a double headed locomotive, built by Mason, of Taunton, after a style invented by Robert Fairlie of England. This ponderous and unique machine, which is to become the property of the Boston and Albany Railroad, drew hither from Worcester the other day 40 freight cars, half of which were loaded. It would have drawn more had not the pump given out, — a defect easily remedied and by no means vital. It will speedily be repaired, and the machine sent on a trial-trip up the hills to Pittsfield immediately. This dual engine has 1 boiler with 2 heads, and at each end rests on 6 drive-wheels. The cab rests on the boiler, over the centre, where a lever lets on the steam. The water-tanks and bunkers for coal are above the boilers on each side of the cab. In going in one direction one-half of the locomotive is going ahead and the other backing, and the latter goes ahead when the steam is reversed, and the other half backs. Thus the necessity of turn-tables is avoided, and it is claimed that the same amount of steam in such an engine will accomplish more than in one of the ordinary kinds." — *Van Nostrand's Eng. Mag.*

RAILWAY AXLES.

In a letter to the "Times" Sir Joseph Whitworth makes a suggestion relative to the construction of railway axles, which is deserving of attention by the engineers of railways. He proposes that a hole should be drilled through the centre of the axle, throughout its length, thus opening up to inspection and examination that part of the material which, in the case of ordinary manufacture, is most subject to unsoundness. The hole should be about an inch in diameter, and, with suitable mechanical arrangements, might be drilled at an average cost of about 1s. 6d., per axle. With the outside turned and the inside thus exposed to view, a serious flaw in an axle, which is only about 4½ inches in diameter, could hardly escape discovery. The plan, he says, would also diminish the tendency of the axle to get heated, and, by renewing the material near the neutral axis, would, under the circumstances, reduce the internal strains, and render the axle safer. — *Van Nostrand's Eng. Mag., Oct.*, 1870.

PUMPING ENGINES.

A set of the largest pumping engines yet made have just been completed by Messrs. Gynne & Co., of the Essex Street Works, Strand; they are to be erected in Denmark for some heavy drainage works, to reclaim 20,000 acres of land for the Nissum Fjird Company, and of the most approved construction. The manufacturers are confident that the engines and pumps will raise 40,000 gallons, 178½ tons, 12 feet high in one minute, which is nearly 50 per cent. more than contracted for. The machinery consists of a pair of engines, 4 feet apart from centre to centre, coupled, with a pump on each side. The engines are 21 inches cylinder expansive condensing, 21 inches' stroke, mahogany lagged, running at 140 revolutions (490 feet piston speed) per minute, and consuming 3 pounds per horse-power per hour; vacuum 27 inches. The pumps are constructed on Messrs. Gynne & Co.'s well-known centrifugal principle, and are 42 inches' diameter in the pipes. The same manufacturers will shortly have completed a combined pumping engine for the Punjaub Railway, to discharge 1000 gallons per minute 60 feet high. — *Van Nostrand's Eng. Mag.*

ELASTIC TIRES FOR TRACTION ENGINES.

"Engineering" states that an interesting trial was recently carried out between Rochester and Chatham of a 5-horse traction engine constructed by Messrs. Aveling & Porter, of the former place, and fitted with tires formed of India-rubber segments attached to iron plates by a process patented by Messrs. L. Sterne

& Co., Great Queen Street, Westminster, these plates being bolted to the wheel-tire and further secured by iron rings. The front pair of driving-wheels of the engine are 3 feet 6 inches in diameter, and are fitted with India-rubber segments 12 inches long, 4 inches wide, and 3 inches thick. The rear pair of driving-wheels are 5 feet in diameter, and are fitted with India-rubber segments 12 inches long, 6 inches wide, and 3 inches thick. The rubber is firmly attached to one-fourth inch steel plates, which are bolted on to the one-half inch wrought-iron tires, the segments being still further secured by five-eighths inch wrought-iron rings placed on each side of the wheel.

The trial, which was conducted by Messrs. Aveling & Porter, took place on Friday last in the presence of a number of government officials, and some of our leading engineers. The engine started from Messrs. Aveling's works, at Rochester, with 2 long 4 wheel lorries and a load of iron girders, giving a total weight of about 13 tons. It proceeded at a pace of about 4 miles an hour through the slippery streets of Rochester, travelling steadily up Star Hill, which has a gradient of 1 in 12 for more than 300 yards. It made several sharp turnings round corners, the radius of the path of travel being not more than 15 feet. With one ordinary iron skid on the rear wheel of the hindmost lorrie, it descended Rome lane, — a steep falling grade, — under complete control. The rough and irregular stone causeway, the timber bridgeway of the Chatham dockyard, and the rough and broken ground near the landing quay on the Medway, were all smoothly and successfully traversed. The girders were landed on the quay and the engine then returned to Rochester. The ground near the landing quay is full of hillocks of cinder, clinker, stone, bricks, scrap iron, etc., but, although the engine ran over all these substances, not a cut nor permanent indent was to be found afterwards in the India-rubber segments.

The great advantage of Messrs. Sterne's method of attaching the India-rubber in segments over the solid ring is, that if a segment gets damaged it is easily and quickly removed and replaced by a spare segment at a moderate cost. The motion of the engine during the run was easy, and the India-rubber readily impressed itself into the inequalities of the roadways. To avoid all possibility of slip in wet streets and on clay soils, Mr. Aveling proposes to introduce steel staples or crossbars, so arranged as to take the traction without neutralizing the benefit derived from the elastic action of the rubber. There is no doubt a decided advantage in Messrs. Sterne's method of utilizing the India-rubber. Traction engines with their wheels thus tired will prove useful under the special local circumstances, such, for instance, as where they have to traverse paved or very uneven roads. But here, to our mind, the advantage of rubber-tired wheels ceases, and we believe that the engine in question, or, in fact, any of Messrs. Aveling & Porter's engines, would work as well without as with this addition, and that in most cases the 130*l*. or 140*l*. which these appliances cost could be more profitably expended on the engine in other ways.

We may observe, in conclusion, that there is no fear of the rubber parting from the plates to which it is attached by Sterne's process. Its adhesion has been tested by Mr. Kirkaldy, who found that a direct pull of 6,216 pounds, or 177½ pounds per square inch, was required to separate the two. In compression the rubber segments stood 66¼ tons per square foot, returning to their normal condition after the pressure was removed.

THE USE OF WIRE ROPE IN CIVIL AND MECHANICAL ENGINEERING.

A marked feature of present mechanical progress is the increasing use of wire rope in civil and mechanical engineering. The world probably owes a greater debt to the late John A. Roebling than to any other man connected with the introduction of wire cables as a constructive material. It was he who, by his scientific employment of this material, educated the public — at least the American public — up to the full appreciation of its value. From his labors and experiments the principal data upon which other engineers now depend in the use of wire for constructive purposes have been chiefly obtained.

Now we find wire rope employed in almost every engineering work. It constitutes an important part of modern ship-rigging. It is used for hoisting, for towing boats, for bridges, for suspended tramways, for propulsion of cars up heavy grades, and even upon level surfaces. It is found to be the cheapest and most efficient medium for the transmission of power to long distances. Every year increases the number and extent of its applications.

Two of the most recent applications to which this material has been put are, in our opinion, destined to prove equal in importance to any which have preceded them. We allude to the transmission of motive power, and the tramway system invented by Mr. Hodgson, of which several notices have recently appeared in these columns.

The telo-dynamic cable system is, if we mistake not, destined to a most brilliant future. This country affords a notable field for its advantageous employment. Our mining districts are, many of them, so situated that power can only be obtained in this manner, or by the use of steam.

We do not entertain a doubt either that the wire-rope tramway system will be found of vast benefit to our mineral districts. It is simple, practical, and cheap, and has demonstrated its value as a means of transporting ores and freights.

To what other uses wire rope may be destined it is impossible at present to say, but the success which has attended its applications thus far encourages the belief that inventors and engineers may still find it a valuable resource for purposes not yet thought of, and in ways hitherto undiscovered. — *Scientific American.*

THE WIRE-ROPE TRAMWAY AT BRIGHTON, ENGLAND.

place, and [illegible]rope transport system may be described as consisting
tached to iron p[illegible]wire rope running over a series of pulleys carried

by substantial posts which are ordinarily about 200 feet apart. This rope passes at one end of the line round a drum, driven by either steam, water, or even horse power in small farming operations, at a speed of from 4 to 8 miles per hour. The boxes in which the load is carried are hung on the rope at the loading end by a wooden V-shaped saddle, about 14 inches long, lined with leather, and having 4 small wheels, with a curved pendant, which maintains the box in perfect equilibrium while travelling, and most ingeniously, but simply, enables it to pass the supporting posts and pulleys. By a sliding-ring arrangement the boxes or buckets are easily emptied by tilting, without unshipping the saddle from the rope. The boxes can be made to carry from 1 cwt. to 10 cwt., and the proportions of the line and the loading and discharging arrangements can be varied to suit any particular requirement, ranging from 10 tons to 1,000 tons per diem. At each end of the line are rails placed to catch the small wheels attached to the saddles of the boxes, by which means the weight, having acquired momentum, is lifted from the rope, and, thus suspended from a fixed rail or platform, can be run to any point for loading or emptying, and again run on to the rope for transport, the succession being continuous, and the rope never requiring to be stopped for loading and unloading.

Curves of sharp radius are easily passed, as well as steep inclines, and its applicability to cross rivers, streams, and mountains, or hilly districts, will be apparent at a glance, as the cost of construction increases but little under such circumstances, whilst that of a road or railroad is, perhaps, increased tenfold, and the daily working cost doubled or trebled. The rope being continuous, no power is lost on undulating ground, as the descending loads help those ascending.

In the case of lines for heavy traffic, where a series of loads, necessarily not less than 5 cwt. to 10 cwt. each, must be carried, a pair of stationary supporting ropes, with an endless running rope for the motive power, will be employed, but the method of supporting, and the peculiar advantage of crossing almost any nature of country with a goods line without much more engineering work or space than is necessary for fixing an electric telegraph, without bridges, without embankments, and without masonry, exists equally in both branches of the system.

In the minor applications, such as short transport from mines to railways, the landing or shipping of goods in harbors and roadsteads, and the carriage of agricultural produce on farms, some peculiar features of the system render it specially advantageous. Amongst these are the facility with which power can be transmitted by the rope and taken off at any required point for mining or other purposes. In lines terminating on the seaboard, or on great rivers, a manifest advantage is secured in the facility for taking goods direct to or from ships in harbor or roadstead without transhipment into lighters.

Seen from a distance, the posts which carry the tramway wires at Brighton might be mistaken for telegraph poles; but a nearer inspection reveals a second line of wires on the same level, and upon these 2 wire-rope lines, supported on standards at intervals varying from 300 feet to 1,000 feet apart, — according to the requirements of the ground, — are suspended iron boxes for the carriage of the goods, which boxes pass on noiselessly and steadily, carried forward by the rope at the uniform rate of 5 miles an hour, — the time required for performing the entire circuit of the line.

In laying out these 5 miles at Brighton, the opportunity has been taken of exemplifying the working of the system under every variety of difficulty that could possibly present itself; thus we have at one part an incline of 1 in 6, up and down which the rope and boxes work with perfect facility, the descending weights assisting those which are ascending; then there are, besides several bends less acute, two instances of absolutely right angles which are passed with the greatest ease. In some instances the standards are carried to the height of 70 feet, to meet inequalities of the ground, undulating and hilly country being more trying to this system than craggy and mountainous, — such as that for which this plant is designed, and where, from the long reaches taken, fewer posts will be required.

The line is rather over 5 miles long; there are 112 posts, or standards, in the whole length. These standards can either be made of light angle and band iron neatly put together, as in the present case, or of wood. The rope is made of charcoal iron, is 2 inches in circumference, each strand, as well as the centre of the rope, having a hempen core, to secure ductility. The power employed to drive the rope is a portable 16 horse-power engine.

Some of the spans are 600 feet and 900 feet in length, and ingenuity has been shown in devising every possible mode of testing the merits of this system of transport; and we are bound to record that all difficulties have been overcome with complete success. The line is capable of delivering 240 tons per day of 10 hours, that is, 120 tons in each direction.

This tramway has been erected by Mr. Hodgson, the inventor, at the request of some gentlemen with whom he was in negotiation, for the supply of materials for a line 60 miles in length in Ceylon.

It is intended to divide the proposed Ceylon line, of 60 miles, into 5-mile sections, such as the one described, — 1 engine working every 2 sections, and the boxes passing each section by shunting arrangements, similar to those used at the termini, from one section to another. The line in work will be open daily to public inspection during the month of April, and is well worth a visit. It is hardly likely that so efficient and economical a means of transport will be for long exclusively confined, as at present, to the conveyance of goods. For ourselves, we venture to confidently predict an early adaptation of the principle of this ingenious system to passenger traffic. — *Condensed from Scientific Opinion.*

EXTRACT FROM THE REPORT OF COL. W. A. ROEBLING, CHIEF ENGINEER OF THE N. Y. BRIDGE CO.

A boring made in 1867 showed gneiss rock at a depth of 96 feet below high water. The strata penetrated consisted in the first place of surface filling through alternate layers of hard pan and boulders of trap embedded in sand and clay. Below 50 and 60 feet depth the material was so compact that the bore hole stood without tubing for weeks. No necessity existed, therefore, for going down to rock; a depth of about 50 feet would suffice. But the great desideratum to be attained was a uniform character of the soil over the whole space of the foundation whatever the depth might be. It is well known that the drift formation of Long Island presents a great variety of strata in comparatively short diagonal distances. Within a hundred or two feet on either side of this foundation, there is no bottom, so to speak, and piles are driven a great depth into mud; whereas in the centre of our foundation the depth of water was only a few feet; the existing ferry slip had been blasted out at a great expense, and to drive an iron-shod pile even 2 feet into that material was the work of hours. This hard material, however, occupied only a part of the foundation, which comprises an area of 17,000 square feet. One-third of the area towards the east was much softer in character; to meet the requirements of the case a heavy, solid timber foundation was decided upon, of sufficient thickness to act as a beam, and having the requisite mass to insure a uniform settling. The importance of a uniform foundation becomes evident at a glance when we consider the size of the tower, weighing 35,000 tons, with a height of 300 feet above the foundation upon which the permanent pressure is 4½ tons per square foot. In addition, the buoyancy of the timber enables us to dispense with the screws ordinarily used in towing a caisson.

In regard to durability, it is well known that timber immersed in salt water is imperishable, and to protect it against worms it is merely necessary to sink it beneath the river bed. It at once suggested itself to make the timber platform as far as possible a part of the caisson. This has been done by making the roof of the caisson a solid mass of timber, of 15 feet in thickness. The object and purposes of a caisson in sinking a pneumatic foundation is too well known to need any description here; it is merely a diving-bell on a vast scale. It may well be said that, since the unparalleled achievement of Captain Eads, at St. Louis, the word caisson has become a household word among American engineers.

The caisson of the East River Bridge is a large inverted vessel or pan, resting bottom upwards, with strong sides. Into this air is forced under a sufficient pressure to drive out the water. Entrance is had to the large working-chamber, thus formed underneath, through suitable shafts and air-locks. The material is taken out through water-shafts, open above and below, and 2 supply-shafts send down the material subsequently needed for filling up the air-chamber.

The dimensions of the caisson are rectangular; length 168 feet, width 102 feet, height 9 feet 6 inches. Thickness of roof 5 feet. The sides form a V, and are 9 feet thick where they join the roof, sloping down to a round edge. The inner slope of the V has an angle of 45 degrees. The lowest part of the slope is formed by a semicircular section casting, protected by a sheet of boiler plate, which extends up 3 feet each side. A heavy oak sill rests on the casting, and it consists of a stick nearly 2 feet square. The 3 succeeding courses are laid lengthwise, after that the alternate courses are heading courses. The whole mass is thoroughly bolted together by drift bolts, screw bolts, and wood-screw bolts. In addition there are heavy angle irons uniting the V to the roof. At the corners the courses of timber are halved into each other, and strapped together for further security. The roof is composed of 5 courses of 12-inch square yellow pine sticks, laid close together, bolted sideways and vertically, and having a set of heavy bolts running through the 5 courses. The outer edge of the caisson has a batter inward of 1 in 10 to facilitate its descent into the ground.

To make the caisson air-tight, the seams were all thoroughly caulked for a depth of 6 inches, inside and out, and in addition a vast sheet of tin, unbroken throughout, extends over the whole caisson, between the fourth and fifth course, and down the 4 sides to the shoe. The tin on the outside is further protected by a sheeting of yellow pine. The space between the timbers was filled with hot pitch. As air under pressure of 40 or 50 pounds will penetrate wood with ease, the inside of the air-chamber was coated with an air-tight varnish, made of resin, minhaden oil, and Spanish brown. The air-tightness up to the present time is quite satisfactory, and only one-fifth of the air-pump on hand is sufficient to keep the water out.

The yellow pine timber was selected specially for the purpose. It came principally from Georgia and Florida, and much of it was so pitchy that the sticks would not float. The average specific gravity of all the timber was 48 degrees per cubic foot. Every bolt-hole is bored with a large drift to ensure the hold of the bolts. As the construction of the caisson proceeded, the iron work of the water-shafts, air-lock-shafts, and supply-shafts was put in.

The water-shafts, 2 in number, are square shafts, three-eighths boiler plate, properly stiffened by angle irons, and well secured to the caisson. They are 7 feet by 6 feet 6 inches, and are open above and below, the lower edge extending 20 inches below the edge of the shoe. The water inside of them rises and falls with the state of the tide outside. The material to be taken out is shoved under the edge into the water-shaft by the laborers inside, and is then taken out by the so-called clam-shell dredge of Morris & Cummings, of New York, the only known instrument which possesses the precise action of the human hand in picking up things. Any other arrangement for excavating in the shape of a revolving dredge or a sand-pump was out of the question. The air-shafts are 3.6 feet in diameter, and extend simply through the timber on top of which the air-locks are placed. The supply-shafts are 2 inches' timber, 21 inches' diameter, and of indefinite length, — they have a door at the bottom and one on the top with an equalizing pipe. They are filled full of made air, and the whole contents fall into the air-chamber below.

It was the original intention to have made the air-chamber under the caisson one entire space without any divisions into compartments, thus facilitating the excavation of the material. Various considerations led to the abandonment of that view. Since the caisson was to be launched like a ship, a certain number of launching-ways were required, and these required a stiff frame from the launching-way up to the roof. Again, in the boulder soil, only a few points of the edge would have rested and supported the weight at any one time. But the chief point was the rise and fall of the tides and their effect on the caisson. The extreme rise and fall is 7½ feet. If the inflated caisson is just barely touching the ground at high water, it will press upon the base with a force of 4,000 tons at low tide, all of which has to be met by the strength of the shoe and the frames. And it is not until the caisson is permanently righted down that the continuous excavation can take place inside. The frames are proportioned somewhat to the strains in launching, and form a heavy truss of pine posts and stringers with 3-inch sheathing on each side, and side-braces to the roof every 6 feet. The ends of the frames are secured to the sides or the V by knees.

It was concluded to limit the pressure of the caisson during the launch to 2¼ tons per square foot of launching surface. This required 7 ways in all, 2 under the edges and 5 under the frames. The total launching weight of the caisson was 3,000 tons, containing 111,000 cubic feet of timber and 250 tons of iron. It was launched sideways, — that is, with the long face of 168 feet by 14 feet 6 inches high facing the water. The ground-ways were laid at an angle of 1 inch per foot, the caisson standing 50 feet back from the end of the ways. To buoy up the forward end of the caisson as it entered the water, and thus prevent its entire immersion, a temporary water-tight compartment of 2-inch plank was put in, one-third the distance across. It served its purpose admirably. A full complement of wheel-barrows, crabs, and winches were likewise stowed away in it. The ground-ways consisted of 2 timbers, of 11 inches square each, bolted together sideways. They were grooved like the guide of a planer, and the upper launching-way fitted their grooves correspondingly. The great danger of launching so large a mass on 7 ways consists in the liability of one end going faster than the other, and thus wedging the caisson fast on the ways. Only the outer ways were provided with ribbands. They, however, proved superfluous to accelerate the motion of the caisson as it entered the water, and thus overcome the increasing resistance. The ways were laid crowning to the amount of 18 inches in their length. The launching-ways were likewise continued 10 feet back of the caisson, and provided with shoes against the sides; it was desirable that the rear edge of the caisson should leave the end of the ground-ways uniformly, and not stick fast on one, — a thing likely to occur, since the ways stopped at the low-water line, and the rear edge would fall at once into deep water. The above arrangement answered the purpose.

On the 19th of March, 1870, the launch took place; in every respect a success. As soon as the last block was split out, the caisson commenced to move. The impetus it had acquired in the first part of its course proved sufficient to overcome the immense resistance offered by the water. The caisson has daily been rising with every high tide and resting on the ground again at low water, requiring most of the work inside to be done at low water, where the caisson is comparatively free from water. As the edge does not readily sink into the hard soil, it is expected that there will always be some water. Since the edge of the shoe is rounding, it allows the air to blow off before the level of the water has reached the lowest limit. This is caused by any trifling agitation in the level of the water inside, which gives the escaping air a chance to establish an outgoing current before the head of water inside becomes sufficiently great to overcome it.

By constantly building up on top the centre of gravity has been raised considerably, and the caisson is now in a condition of unstable equilibrium, — that is, it does no longer rise uniformly with the rise of the tide. One end will remain on the ground and the other rises as much more in proportion, and the more it rises the more surface it presents to the upward pressure of the air on that side, the general level of the water inside being governed by the level of the highest point of the shore.

This rising of one end of the caisson is attended by another phenomenon of imposing appearance. As the tide rises, and the downward pressure of the caisson is about being overcome by the increased tension of the air inside as well as the buoyancy of the water outside, one end of the caisson will suddenly rise 6 inches or more. The result is that for a few minutes the tension of the air inside exceeds the head of water outside, and a tremendous outward rush of air takes place under the shoe, carrying along a column of water of hundreds of tons to a height of 60 feet at times. This continues until a return wave inside of the caisson checks it. These blow-offs are not felt to any extent by the men inside, beyond the warning noise and momentary draft created.

The magazine of force contained in 170,000 cubic feet of compressed air is so large that the loss of a few hundred tons is a trifle. A system of pipes is put in the air-chamber for the purpose of illuminating the air-chamber with calcium lights, a trial of which has resulted favorably; with moderate pressures, candles answer very well. The first course of stone is now being laid. Its weight, together with the concrete on top of the timber, will probably suffice to ground the caisson permanently, and thus permit the erection of setting derricks on the caisson. The stone setting will then keep uniform pace with the excavation, and by the time the desired point is reached the masonry is far above the water level.

The stone used for these land courses, which will be permanently under water, is the Kingston limestone, furnished by Noon and Madden. These stones have both beds cut, but the sides and builds left rough, with vertical quarry joints, the projections not exceeding 2½ inches. The beds are exceptionably wide. As the base of the masonry work resting on the timber is very much larger than the section of masonry at the water level, it is considered that this class of masonry is equally as good, and certainly far cheaper than regular dimension stone. All the stone in any one course are cut to a uniform size. Above low water granite will be used on the water face, and subsequently throughout as freestone.

The first or corner-stone of the extensive pile of masonry to be raised above the caisson, unlike as it was to ordinary affairs of this kind, was a massive block of limestone from the quarry at Kingston, Ulster Co., and in extent was 3 feet wide by 8 in length, weighing about 5,800 pounds, or 165 pounds to the cubic foot; and it is of this material that the foundation below low-water mark will consist.

Additional borings are now being made for the New York tower. The boring made 2 years since was 400 feet away from the actual site of the tower. This one is directly on it. The same stratum of 30 feet of the finest quicksand has been penetrated, but boulders have been encountered at a depth of 80 feet, and the indications are that rock will shortly be reached.

CONCRETE AND IRON BRIDGE.

A new bridge erected for Sir Shafto Adair, from the designs of Mr. H. M. Eyton, of Ipswich, over the Waveney, at Homersfield, England, has been recently tested. In designing the bridge advantage was taken of the principle of Messrs. Phillips' patent fire-proof construction, — a system in which all the iron-work is completely embedded in Portland cement concrete. The bridge has one arch of a clear span of 50 feet, with a rise of 5 feet 3 inches. The skeleton of the bridge is of iron, and this is entirely filled in with Portland cement concrete, and rendered with Portland cement, thus forming one continuous beam, getting stronger every year, in addition to the iron skeleton, which is of itself sufficient to do the ordinary statical work of the bridge; the weight of concrete alone is over 100 tons. The spandrels of the bridge are relieved by a raised panel, and in the centre is a casting of the Adair arms, taken from the old 3-arched brick bridge. The first test applied was that of a 5-ton road roller drawn by 4 horses. This was passed across several times, and not the least deflection was perceptible. Afterwards a heavy wagon, laden with sacks of flour, weighing altogether 6 tons, was passed over, and still, it is stated, no deflection could be noticed.

BRIDGE OVER THE DNIEPER.

The *railway bridge lately* erected over the Dnieper, near

Kiew, is the largest work of the kind in Europe, being 3,503 feet in length.— *Van Nost. Eng. Mag.*

THE BROADWAY UNDERGROUND RAILWAY

Commences at the foundation lines of the splendid marble building on the corner of Warren Street, and extends in a curve directly down Broadway. The lower terminus is intended to be at the South Ferry; but the present operating section only extends a little below the City Hall, near to the north end of the new post-office premises, a distance of some 300 feet.

The bed of the railway is 21 feet below the surface of Broadway, and the diameter of the tunnel 9 feet. The passenger car is about the same size as the ordinary street cars. It is very tastefully fitted up, brilliantly lighted, and has seats for 22 persons. It is propelled by the atmospheric system; that is to say, by means of a strong blast of air which is supplied to the tunnel by a gigantic blowing-machine.

The whole operation is described as being exceedingly simple and effective. The visitor enters at the corner of Broadway and Warren Street, descends a few steps to the waiting-room, — an elegant apartment, but wholly under ground, — at the end of which is seen the mouth of the tunnel and the car. On taking seats in the car, the conductor closes one of the doors and touches a telegraph signal, when the car immediately begins to move around the curve, and travels rapidly down Broadway. On reaching the lower end of the tunnel, the car moves instantly back again to Warren Street, then down Broadway again, and so on. The air is so elastic that the changes of motion in the car are effected with exceeding gentleness, and are almost imperceptible to the visitor.

The car is run by telegraph; that is to say, the wheels of the car, at certain points on the route, press a telegraph key, sending a signal to the engineer, who turns a valve and thus reverses the air-current, without stoppage of the machinery.

The aeolor, or blowing-machine, by which the air-current is produced, consists of a pair of great wings, geared together, and turned by steam. It is capable of discharging 100,000 cubic feet of air per minute, or enough to fill the interior of 3 3-story city dwelling-houses.

The south end of the tunnel is provided with a lateral air-shaft, which opens in the grass-plot of the City Hall Park. The air-current thus traverses through and through the tunnel, the atmosphere of which is thus kept pure and fresh.

During the construction of the tunnel the entire travel of Broadway, omnibuses, carts, hacks, and other vehicles, in endless procession, passed on as usual, directly over the heads of the workmen. They were safely protected within the sides of an immense boring-machine, by which the bowels of the street were excavated. It is pushed forward into the earth by means of powerful hydraulic rams; and as fast as it advances the masonry is built up within its rear.

The works of the Broadway Underground Railroad, taken altogether, are of a most interesting nature, well worthy of examination. The general plan of the Company is to lay a double line of tubes from the South Ferry, under Broadway, the entire length of the island, with a branch at Union Square, under Fourth Avenue, to Harlem River. Such a road would have capacity for carrying 40,000 passengers per hour.

ROTARY PUDDLING FURNACES.

A number of puddlers, of this character, have, for some time, been in successful operation at the Cincinnati Railway Iron Works, and have attracted considerable local attention.

The machine puddlers dispense with the hand labor of the usual furnaces, performing the same duty by steam power. Those at present in operation are making puddled balls of from 650 to 700 pounds in weight; and others, of greater capacity, are in process of construction. Samuel Danks, of that city, is the inventor.

SUSPENSION BRIDGE AT PITTSBURGH, PA.

This bridge crosses the Alleghany about half a mile above its junction with the Monongahela, both of which streams, when united, form the Ohio. The town of Pittsburgh is situated on the promontory made by the convergence of these two rivers, and has, with its suburbs, a population of about 200,000. The distance between the abutments of the bridge is 1,037 feet 5 inches, being divided into 2 main spans of 344 feet 6 inches each, one-half span of 117 feet 5 inches, and a second half span of 171 feet. 4 wire cables carry the structure; the 2 outer ones incline outwards from the towers, and the 2 inner inwards, to give stability to the bridge. The lighter cables which carry the footway are each 4½ inches' diameter, that of the others being 7½ inches. The roadway is 20 feet wide, and the footways each 10 feet. The cables are attached to bell-cranks at the towers, instead of by saddles placed upon rollers, — a by no means satisfactory arrangement, the vibration of the bridge being increased perceptibly by the lightest passing load. The towers are about 45 feet high. They are of cast iron, and of an ornate character, the weight they support being entirely carried by the 4 inclined columns, which are braced together by latticed castings. — *Scientific American.*

A STEEP RAILWAY.

A railway has been constructed in Pittsburgh, Pennsylvania, to carry passengers to and from the top of what is known as Coal Hill, which overlooks the city and the country around to a great distance.

The plane is located 250 feet west of the Monongahela suspension bridge. The roadway starting from Carson Street crosses the

Pan Handle Railroad, and reaches the face of the hill (which at this point is 90 feet above the level of the Pan Handle Railroad track) by means of an iron bridge 160 feet long. This bridge is supported by 10-inch columns, made of wrought iron a quarter of an inch thick. The vertical height of the hill at this point is 330 feet, giving the plane a length of 650 feet, and an inclination of 35 degrees. The roadway consists of 2 tracks, each 5-feet gauge, with 2 cars, — one ascending while the other descends. The cross-ties on the iron bridge are yellow pine, 7 feet by 7 feet. The stringers are also yellow pine, 6 by 8 feet, and the ties on the balance of the track 8 feet by 8 feet. A pine railing runs from the base to the top of the incline. It is 3 feet high, and quite fancy. It is to be painted — probably white. The rails are of the "T" pattern, and substantially fastened to the stringers.

The cars are to be hauled up by a wire rope, and are provided with a safety-cable, which runs idly except in case of the breakage of the principal rope, when the drum about which the safety-cable winds is held by means of a brake, thus preventing the accidental descent of a car. — *Scientific American.*

THE NEW TUNNEL UNDER THE THAMES.*

The new tunnel does not detract from the merits of Brunel's great achievement in constructing the renowned passage between Rotherhithe and Wapping, but it is as great a wonder in its way, and in several respects offers a marked contrast. The old tunnel brickwork is 38 feet wide by 22½ feet high; the new tunnel consists of an iron tube about 8 feet diameter over all. The old tunnel was worked by a shield weighing 120 tons, accommodating 36 workmen; the new tunnel has been driven by a shield weighing 2½ tons, and accommodating at most 3 workmen at a time. The old tunnel was 5 times filled by irruptions from the river; in the construction of the new tunnel the water encountered might at almost any time have been gathered in a stable pail. 18 years elapsed between the commencement and the completion of the works in one case; less than a year has sufficed for the execution of the works in the other. The descending shafts of the one were 84 feet deep and 50 feet diameter; of the other they are under 60 feet deep and 10 feet diameter. The cost of the one was over £600,000; of the other it has been under £20,000.

At the Tower Hill shaft we found the lift in which passengers are to ascend and descend fitted and at work. It is an iron chamber nearly cubical in shape, and large enough to accommodate 7 or 8 persons comfortably. The entrance is by a pair of sliding doors. Guide-rods are attached to opposite sides of the shaft, and corresponding grooved rollers are fixed to the sides of the lift. The lift is balanced by a large cast-iron weight with an open centre to admit of its being loaded in accordance with the number of passengers that have to be raised or lowered. There is a continuous connection above and below between the lift and the balance weight by chains and wire ropes, calculated for 50 times the strain that can ever be put upon them. These pass over pulleys at the top and bottom of the shaft. The balance weight works also in a pair of guide-rods. Mr. Barlow has designed a brake attached to the roof of the lift, and acted on by a powerful double-handed screw on the inside of the roof. The effect of applying the brake is to release 2 arms which clip the guiding-rods on each side, and effectually stop the descent in a few feet. At the bottom of the shafts, and under the level of the subway, are engine-rooms and coke-cellars. The engines at each end are of 4 horse-power, and these will at any time supply more than sufficient power for all purposes. The lifts are adjusted at each end with their doorways inwards towards the subway. On emerging at the bottom of the shafts, the passengers enter a chamber, which constitutes the "station," at and from which the one omnibus, which constitutes the entire "rolling stock" in use at one time, arrives and departs. There is space in these waiting-rooms for a seat along each side. We found the workmen at the Tower Hill shaft busy with the fittings and finishings of this chamber, and passing thence we entered the subway and proceeded through its entire length under excellent guidance. Ordinary passengers, when the tunnel has been opened for traffic, will not realize the curious sensation and experience of a passenger through on foot, from the noises overhead, on and near the river, so distinctly heard in the subway, which is air-tight as well as water-tight. Arrived at the Tooley Street end, we found the waiting-room occupied by the light iron omnibus in which passengers are to be conveyed. The vehicle, seated for 14 passengers, is tolerably roomy as regards width, but is necessarily rather low in the roof. The seats, cushioned and with stuffed backs, are placed lengthways, the entrances being at the ends. The wheels are 16 inches' diameter, and at each end of the carriage a powerful lever brake is fitted, to be worked by the conductor with his foot. The service will of course be of the shuttle character, the 2 halves of the omnibus being duplicates, the front end of the vehicle in one journey being the hinder end in the return. The gauge of the rails is 2 feet 6 inches, and the descent from each end to the centre of the subway is by a gradient of 1 in 30. We found the works connected with the Tooley Street shaft rapidly approaching completion, but not quite so near it as those at the north end; the subway itself may be pronounced finished, and the omnibus fit to take the road at any moment.

The omnibus will be hauled by a wire rope running upon a horizontal pulley-wheel fitted between the rails at one end, and passing round a vertical pulley-wheel at the other.

THE KANSAS AND MISSOURI BRIDGE.

This bridge was designed and located by Mr. W. W. Wright, Engineer in Chief, and is being constructed under his supervision. The superstructure is to be of wrought iron, resting upon cast-iron piers, formed of large pneumatic piles sunk to a bearing on solid rock. These piles are 8½ feet outside diameter, with a thickness 1¾ inches, and weigh about 1 ton to the square foot in height. They are manufactured in sections of 10 feet in length, with inside flanges at both ends to enable them to be connected together during the process of sinking, and thus form a continuous cylinder from foundation to bridge-seat. These columns will be filled with cement masonry and concrete from the bottom to an elevation 10 feet above high-water line. There will be 2 piers of this kind in the river, and 1 on the eastern shore. The western end of the bridge will rest on a stone abutment. The 3 spans thus formed will be each 340 feet in length, and the bottom of the lower chord will be 50 feet above extreme high water, thus leaving ample space between the piers and sufficient height above the surface of water for steamboats to pass at any stage of the river. The approach to the bridge at the eastern end will consist of a substantial trestle work 1,500 feet long, connecting with an earth embankment extending 2,500 feet further.

LATTICE GIRDERS AND SOLID PLATES.

The English magazines have of late been devoting much space to a discussion of the relative merits of solid plates and lattice girders, and though the question is certainly an important one, entailing, as it does, almost a revolution in the methods of construction, in case lattice girders possess all the advantages their advocates claim, yet the topic is still discussed, and the solution of this problem in mechanics seems nearly as far off as ever.

Those who rank among the more modern class of thinkers, who first theorize and then demonstrate, claim that the lattice will, for the same amount of material, sustain greater strains and endure shocks much better than a homogeneous plate, and the argument sustaining this claim is based chiefly upon the fact that iron will resist a greater force, applied in the direction of its fibres, than when across them, and it is claimed that mathematical analysis will render possible such an arrangement of the parts of the lattice that all, or nearly all, the strain will be in the direction of the grain or fibre of the iron.

Now, if we admit, what we certainly cannot prove to be false, that the engineer can, from pure theory and by the aid of mathematics, so place and arrange the parts of a girder that the strains will be in the direction of the fibre, and proportionate to the size of the pieces, we can draw a strong comparison in favor of open or lattice work.

No scientific man will deny the fact that a wire rope is both lighter and stronger than an iron rod of the same diameter, or, if he claim the privilege of comparing the actual sectional area, taking the sum of the sectional areas of the individual wires, we can still claim greater strength for the rope upon the ground of more perfect structure, as proved by experiment, — the weight, of course, being the same, or nearly the same, in either case. English bar iron will resist about 60,000 pounds' tensile strain to the square inch, before parting, while wrought iron will resist over 100,000 pounds for the same actual area. Now, compare the lattice and plate in the same way. The plate corresponds to the solid bar and the lattice to the wire rope, and the openings to the space between the wire. Here we have undoubtedly so placed the direction of the strain that it is all with the fibres, and find that we have the proportion of 10 to 6 in favor of the structure composed of several separate pieces.

Now, though this is perhaps an extreme case, and the argument only one by analogy, yet, while perhaps the same proportions would not exist between the degrees of resistance afforded by lattice girders and solid iron plates as between the different qualities of iron, from the superiority of construction obtained in the former, the reasoning will apply most forcibly. It will probably not be denied that the superiority of construction claimed really does exist, and this one argument is, therefore, taken alone, convincing.

But, after all, the matter of the relative strength of the material in different cases is really of less importance than is the apparently simple problem of fastening the parts together. If, after being properly arranged, the parts of the lattice can be so fastened together that each piece will do its entire duty without unduly straining its neighbor, there can exist no doubt that the lattice will be stronger than the iron plate girder, with its present form and arrangement; but, on the contrary, could the plate be placed in such a way as to be of equal strength at all points, without increasing the weight of the structure, the iron plate would certainly rival the weak forms of lattice as now constructed. Upon the ground that this perfect construction cannot be obtained in a solid plate, the advocates of the lattice girders rest their claim, and it would seem that their assertions cannot, as regards this point, be readily controverted. — *American Builder.*

SINKING SCREW PILES.

A machine has been lately designed by an English firm, at the request of H. Lee Smith, Esq., chief engineer for the Punjaub Northern Railway, for screwing down piles to be used in constructing bridges and flood openings on that line of railway. This machine consists of a wrought-iron under-carriage mounted upon wheels of 5 feet 6 inches gauge, and carrying a vertical boiler at one end. A strong cast-iron beam in the centre carries a cylinder in which works a ram, to the top of which a strong cross-beam is bolted which carries the machinery for operating on the piles. This consists of a horizontal steam engine bolted to the side of the cross-beam, and driving a pinion and train of spur and bevel wheels which impart motion to two large horizontal wheels carried in bearings at each end of the cross-beam. A friction clutch is carried in the centre of each of the wheels, through the boss of which the shaft of the pile to be screwed is passed. The shafts are rolled with feathers or ribs on each side, which, passing through corresponding recesses or keyways formed in the boss of the friction clutch, form the means of imparting motion from the horizontal wheels to the piles; steam is brought from the boiler, through the centre of the ram and cylinder which carries the cross-beam, by means of a telescope joint, which allows the ram to be raised without interfering with the steam pipe; and a small donkey engine is provided which can pump from a tank situated between the frame, either into the boiler or into the cylinder under the ram which carries the cross-beam. When the machine is at work the cross-beam is held firmly by means of cotter bolts to the frame. The modus operandi is as follows: A temporary road being laid on the centre line of the proposed structure, piles are pitched by passing the shafts through the wheels on each side of the machine, and keying them into screws which are placed in a small hole excavated to receive them. The engine is then set to work, and the piles screwed down as far as possible. The cotters holding the cross-beam are then removed, and it is raised by the donkey engine pumping into the cylinder of the machine, and lifted off the piles. The machine is then moved forward to the centre line of the next pile, and the operation takes place as before. — *Journal Franklin Institute.*

TRANSFORMATION OF CAST IRON.

"Transformation of Cast Iron, Wrought Iron, and Steel, by means of the Vapors of Alkaline Metals," — such is the title of a patent taken in France, by MM. Charles Girard and Jules Forlain (date 17th August, 1869, No. 86,784), the particulars of which we extract from our excellent contemporary, the "Moniteur Scientifique:" —

"In order to cause the vapors of sodium and potassium to act on cast iron in fusion, we heat one of the former metals in an iron retort to 392° or 482° under a pressure of 5 or 6 atmospheres. When this heat is reached we direct the vapor thus obtained into the heart of the iron in fusion; the mass swells, and an alloy of the iron is the result. These alloys, although very hard, are malleable, and may be forged and welded. They oxidize rapidly in air or water, and are easily decomposed if a current of air, steam, or carbonic oxide is injected into them when in fusion. By these compound effects of the vapor of sodium and of air, for example, the whole of the metalloids in the iron are attacked, and the final result is pure wrought iron, that can be hammered and welded with ease. Under certain circumstances the metal resulting from the operation may present the properties of steel. Finally, to facilitate the production of the metallic vapors, carburets, rich in hydrogen, may be added to the sodium or potassium in the retort.

"In place of sodium or potassium an alloy of the two may be used; as, for instance, one composed of 4 parts of potassium (melting at 122°) and 2.5 parts of sodium (melting at 194°). This mixture, which has the appearance and consistency of mercury, has its point of solidification at 47.4°, and is consequently liquid at ordinary temperatures. It is prepared under naphtha.

"It has been remarked that, besides the direct transformation of cast into wrought iron or steel, by means of the metals, their action produces other advantages; they allow of the employment of iron castings, which, although containing manganese, cannot be converted by the Bessemer process, on account of the quantity of carbon, sulphur, or phosphorus which they contain. It is, in fact, now proved that the Bessemer process, far from eliminating the sulphur and phosphorus, tends rather to augment the proportion of these metalloids.

"The cast irons known as *chaudes*, and which contain silicium and magnesium, owe a part of their superiority to the calorific power of the silicium (7,800), the produce of the oxidation of which, silica, requires but little heat to disengage it, so that the liquefaction becomes more complete. On the other hand, carbon, under the same conditions, gives rise to the disengagement of masses of sparks produced by the gases, carbonic acid and carbonic oxide, which traverse the mass; these take from the molten matter a considerable quantity of caloric, and are thus unfavorable to liquefaction.

"In our process this latter inconvenience is partly dispelled; for the gases produced by the combustion of the carbon, sulphur, and phosphorus, combining with the soda or potash, are mechanically carried through the mass of metal by the oxidation of the sodium of potassium. The direct action of the sodium or potassium, in the form of vapor, on the melted iron, may be replaced by adding to the mixture of ore, fuel, and flux, either chloride of sodium, carbonate of soda, a corresponding salt of potash, or a mixture of these.

"Acting thus on any given ore, and using coke or coal as fuel, a result analogous to that obtained with charcoal under the ordinary system is obtained. We must add, however, that in the former case the current of hot or cold air should be longer maintained than when charcoal is used; this prolonged application of hot or cold air in the blast furnace may present inconvenience, which may be avoided by directing the alloys of cast iron with sodium or potassium into a converter, in which they may undergo the final action of the current of air; with this process the working of the blast furnace is the same as in ordinary cases.

"We arrive practically at an assimilation of the coke or coal with alkaline salts corresponding to those furnished by wood charcoal, either by watering the fuel with the alkaline solutions above mentioned, and then allowing it to dry in sheds; or, lastly, by pouring a concentrated solution of the various salts on the fuel or the ore at the moment of charging the furnace. We intend to continue our experiments on the alloys and combinations of sodium and potassium with most of the other metals."—*Scientific American.*

IMPROVEMENT IN ENAMELLING IRON AND STEEL.

The process of Benjamin Baugh, of Chadwick, England, of enamelling iron and steel, patented recently in the United States, is as follows:—

Lay upon the surface of the plate of the metal to be enamelled a uniform ground, of any color required to produce the intended design; as, for instance, a name-plate, or tablet, with the ground white and the inscription in blue. The white ground, having been fused on in the melting-furnace and allowed to cool, there is then applied, with a brush evenly over the whole surface, a coating of blue enamel, the materials of which are finely levigated and mixed with gum-Arabic and water, or other mucilage, to form a paste of slightly adherent properties.

When dry, a stencil of the inscription, or of each letter separately, is laid on, and the enamel paste is removed from the parts which are unprotected by the stencil, by the application of a stiff brush, leaving the ground clean, except the letters. The plate is then again subjected to heat, whereby the paste, which is fusible at a lower temperature than the ground previously laid, becomes permanently fixed upon it.

The mechanical removal, by means of a brush, enables very delicate lines to be formed through the paste, to expose the enamel ground, and admits of the use of ornaments having sharp angles and minute points and details to be distinctly and perfectly rendered.

The ground may be dark, and of any color, as well as of the kind described, and the subsequent coat of a lighter color; as, for instance, the ground may be of blue and the inscription white, and a succession of colors may be given to produce a variously colored design, by the same method.

The inscription or design may be cut out in the stencil, and the ground thereby exposed be removed by the brush, instead of the surrounding parts, with a like effect, it being left to the choice of the designer whether this process be followed, or that previously described.

The stencils are formed of very thin sheet metal (or even of paper, where they require to be used but a few times), which, by their flexibility, lie more closely in contact with the surface, and leave the lines and margins of the figures perfect, while they conform to convex and irregular surfaces.

He combines with the method described the use of artistic graphic representations, such as views, portraits, or groups, thereby producing metal tablets decorated in enamel, in a manner adapted to architectural purposes, as the finishing of interiors, panels for cabinet work, etc. Such designs are produced upon stone in the usual lithographic manner, and printed in successive impressions upon paper prepared for transferring, by having its surface coated with gum-Arabic, or other substance that is soluble in water, mineral colors and fluxes being used, which are adapted to fuse under heat, and combine to form the picture in enamel of appropriate colors.

The enamel ground having been fused on, as previously described, for stencilling, it is covered with copal or other suitable varnish, and the face of the prepared picture is laid upon it and pressed, to insure adhesion of all parts, when the paper is removed by wetting, as is ordinarily done in transferring prints. The plate is then subjected to heat until the colors of the picture are fused, and become incorporated with the previously enamelled surface.

IMPROVED APPLIANCES FOR THE PRODUCTION OF HEAVY FORGINGS.

The forging of iron in large masses is a subject of so much importance to our engineering industry that it needs little apology for its introduction to the mechanical section of the British Association, and any improvement in the machinery or appliances for the more economical or rapid manufacture of large masses of wrought iron, or for any improvement in quality, must be of great interest to all manufacturers where such products are needed.

These improvements, in the manufacture of large forgings, I intend to class under 3 heads. I propose simply to mention a few prominent facts very briefly, but shall be glad to answer any inquiries that members may require further information about. 1. Improved heating by Siemens' regenerative gas furnace. 2. Facilities for handling and moving large masses of wrought iron from the furnace to the hammer, and for moving them under the hammer. 3. Improved hammers, with a clean, unfettered fall, and with such width of standards as to give the workman all the comfort and convenience possible in executing the necessary operations of shaping, forging, and cutting the material to the required form.

1st. Improved heating by Siemens' regenerative gas furnace. It is generally admitted that iron in large masses is greatly deteriorated by long exposure to high temperatures, and that a crystalline structure is developed in consequence of such a form and nature as to detract in a very great degree from the strength of the material. It must, therefore, be admitted that furnaces, such as those of Siemens, which produce the most intense heat in the shortest possible time, must cause less deterioration to the product in hand than those which are slower in operation; but a more important item in this consideration is that the facilities given for regulating the admission of gas and air in a neutral flame can be produced; and, in consequence, the iron may be preserved from that burning and oxidation which are the cause of the formation of those large facets or crystals which weaken many wrought-iron structures of large size to such an immense extent.

Another improvement, from these furnaces where the iron is prepared from the pig, is, that the gas furnaces do not bring over the large amounts of unconsumed ash or *débris* from the coal which is usually deposited on the body of the iron made in the ordinary puddling furnace, and, in consequence, the iron is more free from those specks and flaws which are so observable in ordinary iron, and which produce the heating and galling so common in large forgings, as heretofore made, and which cause the chief torment of the practical marine engineer.

Perhaps the greatest advantage which the Siemens' furnace offers is in the manufacture of forgings of puddled steel, from the facility in which the flame of the furnace may be regulated, first, in the puddling process, and, secondly, in the heating of the puddled steel masses. In furnaces of ordinary construction a constant deterioration of the puddled steel must necessarily take place from the free oxygen present in the furnace; but in the Siemens' furnace the gases may be so regulated that a neutral flame is produced, and, consequently, the steel mass is heated without deterioration.

I will not now enter into the question of economy of fuel, as this has been often discussed at meetings of mechanical engineers; nor will it be necessary to enlarge upon the great advantage, especially in large towns, of the absence of smoke, which has been hitherto thought a necessary nuisance in all branches of the iron manufacture.

2d. The second improvement which I would wish to mention is improved facilities for handling and moving these large masses of iron when heated as above described, which is effected by hydraulic cranes and machinery of sufficient power to move these large masses almost instantaneously either from the furnace to the hammer, or *vice versa*, to raise and lower the load, or to increase or decrease the distance of the load from the centre of the crane.

The truth of the old adage, of striking when the iron is hot, will prevent any necessity of dwelling upon the advantage of rapidity of movement in dealing with large heated masses of iron. After the pieces of iron have been heated in the manner described, and when the machinery shown has brought the forging to the hammer, it is necessary that the instrument should be of the most approved description to cope with the material under operation in the best and quickest manner, and with the greatest possible comfort to the workman employed at the work designated. Hammers that are described as suspended are employed; they are carried upon wrought-iron girders, of 20 feet span, which gives the hammer-man such room for his operation, and such freedom from any obstacle to his work, as have seldom, if ever, been accorded before, and so much room to the rear is reserved that shafts 50 feet or 60 feet long could readily be made without any inconvenience. — *Abstract of a paper read by Lieut.-Colonel Clay, of the Birkenhead Forge, before the British Association.*

CORROSION OF IRON GAS AND WATER MAINS.

In an editorial on this subject the "Gaslight Journal" remarks that the deposits which form in the interior of iron water mains cause serious annoyance and loss to many of our water companies. To so great a degree does this evil extend, that strenuous efforts are being made to substitute some other material for iron, which shall possess all its valuable qualities, and at the same time be free from liability to corrosion, and consequent obstruction. The appearance of this internal deposit is very singular and assumes various modifications. Sometimes the corrosion is of a uniform thickness, and appears to attack the surface of the iron evenly, while at others the whole diameter of the pipe is jagged with tubercles of various sizes and shapes, occurring at irregular intervals.

Thus far no satisfactory explanation has been given of the causes of this peculiar deposit. That it is a species of oxidation is very clear, since the mass formed has all the external characteristics of iron-rust; but why it should assume such peculiar physical properties, and present a configuration so unlike the outward forms of other oxidation, has not yet been satisfactorily explained.

The effect of this incrustation is obviously very disastrous to the economical distribution of water, as the diameter of the mains is so much diminished as to reduce their capacity to that of much smaller calibre than they were originally constructed. In addition to this, the strength of the pipe is much impaired by this process of oxidation, and it is rendered much less able to bear sudden concussions and heavy pressure than previous to the formation of the deposit. This must be apparent to all intelligent observers, for it is at the expense of the iron that the incrustation arises. These facts are but too well known to engineers, who are fully cognizant of the difficulty under which they labor in endeavoring to remedy the evil.

The same evil obtains in regard to gas-pipe, only in a less degree. The corrosion forms dust and scales, which drop off in time, and obstruct valves, traps, elbows, and connections. This is especially observable in inclined and vertical piping, such as lamp-posts, etc.

It has been a question with practical men, whether to substitute some other material for iron, or to adopt some means of internally coating iron mains, so as to preclude all possibility of the formation of accretions.

Methods have been tried to coat the interior of iron water-pipes with some substance which would protect the surface of the iron from contact with the water. This would seem to be the only remedy, but attempts in this direction have heretofore been attended with so much expense as to remove one of the strongest arguments in favor of the employment of iron, namely, the economy of its application. Some few years ago, the Water Board in Brooklyn coated the interior of their iron main with a mixture of coal tar and linseed oil, applied at a high temperature, but we have never heard whether that remedy has been effectual in checking the formation of accretions. It was said to impose an additional cost of 2½ dollars per ton on the mains.

Recently, Prof. Henry Wurtz, of New York, has invented a peculiar cement for making gas or water pipes, and especially adapted to coat the interior of gas mains, to make them perfectly impervious even to hydrogen gas, and to prevent corrosion.

Among the materials, other than iron, which have been commended and used to some extent for water pipes, are wood, iron-bound wood, and cement, and bituminized paper.

Plain wooden pipes have been immemorially employed in some places for distributing water, and are still used in many instances. Pipes made of wood and cement have also been adopted to a limited extent. They are durable, easily made, and have been made to withstand a pressure of 400 pounds to the square inch.

The pipes constructed of sheet iron, lined and coated externally with hydraulic cement, are said to be well adapted for distributing water where very cold weather does not prevail, frost being inimical to the integrity of the pipe. So also is high pressure said to be liable to injure the continuity of this kind of piping, especially at the numerous joints and connections.

In England, pipe made of bituminized paper has been employed in distributing both water and gas, but we have not heard that it has become popular to any great extent. It also was attempted to be introduced into this country, but without success, we believe.

Another description of pipe is constructed of wood, being bored from the solid log, lined with cement, and coated externally with coal tar. This form of pipe is said to be extremely durable, and, not being subjected to expansion and contraction by change of temperature, is entirely free from leakage.

In England and France, as well as in this country, the complaints on this score are wide and deep, and a wide field is open for enterprise in introducing an especial remedy.

TWIST DRILLS, AND RECENT IMPROVEMENTS IN THEIR MANUFACTURE.

We condense from a paper recently read, by Mr. G. Lauder, C.E., before the Liverpool Polytechnic Society, the following remarks upon twist drills: —

The last half century has witnessed many important improvements in engineers' tools. Self-acting machines have been introduced and improved, in numbers too great to mention in this paper.

The leading idea which seems to have controlled in all these improvements is what has been designated the "guide principle." As examples, we may cite the slide-rest, the planing-machine, etc., the objects to be attained being, first, greater accuracy in the work performed, and, second, greater speed in performing it.

After improved machines, which have enabled us to attain the first object, we have to look to the forms of the tools used in these machines, to enable us to attain the second object, — speed.

Tools for cutting metals are divided into two classes, namely, paring tools and scraping tools, these being distinguished by the edge they present to the metal being cut.

The data on which our knowledge of paring tools is founded are altogether derived from practice in the workshop, — workmen themselves, he believed, having been, in a great many cases, the leaders in improvement. The best cutting angle has been found, for iron and steel, to be from 60° to 70°, and the angle of relief 3°.

Drills have been the last tools in common use by working engineers to come under the whip of improvement, a large proportion of those now in use being of the worst conceivable form to effect the object they are designed for.

The speaker referred to the common form of drill, and, at the same time, exhibited a sheet of drawings on which a number of different forms of drills were marked. Some of them depend for cutting action on, to use a homely phrase, "strength and stupidness," no attempt whatever being made to form a proper cutting angle. Others are more advanced in form, and have a proper cutting angle provided; sometimes a small portion of the bottom end, he said, is turned, and forms, in this condition, a very excellent working tool indeed. A twist drill was next spoken of, which was the real object of bringing this paper under the notice of the society.

These drills have been known for a considerable length of time, but have not been much used in this country until recent years, Americans having been ahead in their use, and in manufacturing them as well. Strange as it may appear, it is still true, that all the drills of this class were, until within a recent period, imported from the United States.

Due consideration being given to the principles already explained, the advantages arising from the use of twist drills will be apparent at a glance: first, they serve as a common drill, to bore a hole; second, they serve as a guide, while boring, to keep the hole true; and, third, they are so formed as to provide the proper cutting angle throughout their whole working length; fourth, they are tempered throughout their entire working length; fifth, they are ground up true to standard sizes, thus obviating any necessity for dressing. This last advantage will doubtless be highly appreciated by all who have had practical experience of the continual trouble and loss incidental to the wearing out of size of common drills.

The speaker then said, until the recent improvements which I am about to lay before you were perfected, twist drills were formed entirely by the clumsy method of cutting them out of a solid round bar, by means of milling tools, then turning, tempering, and straightening; it is but justice, however, to the parties who have been hitherto engaged in the manufacture, to say that their arrangements and machines for that purpose were admirable of their kind.

The method now pursued successfully in this country differs entirely from that just mentioned. First, the bar of steel which is destined to form the drill is rolled into a special shape; it is then cut into lengths and again rolled in cam rolls, which form a straight groove, after which the shank is formed by cresses. Next the blank, as it is now called, is passed to the twisting-machine, which consists essentially of a hollow spindle having a perforated nut in the end to receive the blank. This spindle, when the machine is started, has a motion of rotation on its own axis, and also a motion of translation in the direction of its axis, being thus adapted to twist the blank, then held firmly at the outer end by vise clamps. Other clamps, worked by suitable gearing, close on the blank as the central spindles clear them;

these serve to hold the twist given to the blank. After a blank is twisted the clamps open, the blank is withdrawn, and the twisting-spindle returns to its starting-point.

After twisting, the drills are centred and rough ground, then hardened by heating in a lead bath and cooling in cold water, next tempered in an oil bath, and finally finished by grinding to a standard gauge.

The main features in this method, to which it was desired to direct attention, are the forging and twisting, in contrast to cutting from the solid bar. One of the principal difficulties, in carrying out the new system just described, was getting the blanks forged, accuracy being essential; this difficulty overcome, the benefits became manifest. Recent experiments have shown that, in shaping metals, nothing is of greater importance than attending to the "flow of the metal." Every particular shape into which a bar of iron or steel is forged having an arrangement of the particles which compose it peculiar to itself, any departure from this natural arrangement is prejudicial. By forging and twisting these drills, this law is paid the fullest attention to, each drill being finished, so far as shape goes, before a single particle of metal is cut from it.

By way of reward for attention to this natural law, the number of drills lost from water-cracks, in hardening, is inappreciable as affecting the cost of production. — *Scientific American.*

THE ROYAL ALBERT HALL OF ARTS AND SCIENCES. A MAGNIFICENT SYSTEM OF HEATING AND VENTILATION.

The subject of heating and ventilation is one of ever recurring interest, and of universal importance. We, therefore, copy from "Engineering" the following description of the apparatus employed in the immense Royal Albert Hall, in London, one of the largest public buildings in the world: —

When it is considered that the Albert Hall of Arts and Sciences, now in course of erection at South Kensington, is to accommodate about 8,000 persons seated, the magnitude of the arrangements for preserving an equable temperature and a pure atmosphere will be realized. The capacity of the hall amounts to 5,000,000 cubic feet, so that the warming and ventilation caused the committee some anxiety, and they invited a limited number of engineers to send in plans for effecting those objects. The various plans submitted were carefully considered, and it was finally resolved to adopt that of Mr. Wilson W. Phipson, Assoc. Inst. C. E., which is now being carried out under his immediate superintendence. The main points by which any arrangement had to be governed were economy in warming, and a satisfactory combination of this process with that of ventilation. The heating-power determined on by Mr. Phipson consists of an arrangement of distinct coils of hot-water pipes, placed in 3 air-chambers. One of these chambers is carried under the main corridor, a second runs beneath the seats of the amphitheatre stalls, whilst a third passes under the arena. These 3 chambers are connected with 2 fans, the combined supply of air from which will be about 3,000,000 cubic feet per hour. One of these fans blows to the right and the other to the left, the fresh air drawn from the outer atmosphere being thus distributed through the chambers. This air, warmed by the hot-water coils, is conveyed to the body of the hall from the chamber under the main corridor by means of channels built in the walls. These channels are also in communication with the corridors, boxes, and all the adjoining private rooms. From the chamber beneath the amphitheatre stalls the warm air finds its way into the hall through perforations in the risers of the seats. From the arena chamber the air enters the building through the interstices between the floor-boards. By these arrangements the entire power of the apparatus may be concentrated on the hall, thus thoroughly warming every portion of it; at the same time means are provided for warming the enclosed rooms independently when necessary. The amount of heating-surface in the iron pipes required to carry out this arrangement is about 28,000 square feet. The temperature the apparatus is calculated to maintain in the hall is about 58° Fah. as a mean during the winter months.

The fresh air is supplied to the fans through 2 air-shafts, 6 feet by 6 feet, which are situated at the south-eastern end of the building, near the Horticultural Gardens. In each of these shafts is placed a self-acting valve, fitted with an index dial which registers the amount of air passing into the building. Arrangements are also provided in these shafts for cooling the air in its passage to the hall in summer by means of sprays of water. The fans are 5 feet 9 inches in diameter, and are to be worked by 2 direct-acting engines of 3 horse-power each. The heating apparatus fixed in the air-chambers consists of 16 distinct coils of 4-inch hot-water pipes, heated by condensing boilers so arranged that each condenser has its direct coil of pipes to work. By this means either a part or the whole of the coils may be utilized, according to the temperature of the external air. These condensers are supplied with steam from 2 boilers belonging to the pumping engines of the Horticultural Gardens. In case of need a supplementary boiler will be provided, which will give a total force of about 75 horse-power.

The *modus operandi* will be as follows: The temperature of the hall will be raised to the requisite degree by the time the audience arrives; as soon as this point is reached, and whilst the public are being admitted, the air-entrances to chambers Nos. 2 and 3 will be partially closed by means of valves. This will allow of only one-sixth of the amount of air necessary for ventilation to pass through these sources. The remaining five-sixths will be distributed by means of 4 separate channels to the air-chamber No. 1, under the corridor. From this chamber the air will be distributed equally all through the entire building by means of the air-channels formed in the walls, to which we have already alluded. It will thus issue upon every floor into the body of the hall, being admitted as far as possible from the audience.

The ventilation is provided for by an opening, having an area of 120 square feet, for the escape of the vitiated air, which is formed in the centre of the ceiling at the highest possible level. This opening is surmounted by a shaft rising some feet above the roof, and which is fitted with regulating louvres. The heat generated by the system of lighting the hall will increase the suction of this shaft at night. During day performances, however, continuous circulation will be insured by a ring of gas-jets from burners with which the shaft is provided.

From a recent visit to the Albert Hall, we are enabled to report the satisfactory progress of the building generally, under the able superintendence of Colonel Scott, R.E. With regard to Mr. Phipson's arrangements, we found that the pipes for heating were all fixed in the outer circle main heating-chamber, and the connections were being made with the steam-pipe to the condensers. About one-third of the inner circle-chamber is completed, and the remainder of the work is progressing. On Wednesday week the wedges between the crown of the roof of the hall and the scaffolding which had previously supported it were struck. The results of this operation were highly satisfactory, the total deflection being only five-sixteenths of an inch. The roof, be it remembered, is of wrought iron, and covers an elliptical area of 220 feet by 185 feet, with a rise of 33 feet. — *Scientific American.*

HEAT BY MEANS OF ILLUMINATING GAS.

"Gas, as a combustible," said M. Cazin, at a recent scientific conference, "offers the best solution of the problem of distribution of motive power in large towns where the illumination by gas is already established. The pipes which furrow our cities convey a provision for light, for heat, and for motive force. We demanded primarily of the gas the first of these agents; we have demanded also the second; it is now time to demand of it all that it is capable of affording. Why should not the same apparatus afford to the workman in his shop light, heat, and power? When gas becomes cheaper this remarkable amelioration of the lot of the artisan will be realizable." We will add that the obstacles to the employment of gas as a source of motive power arise not only from its high cost, but also from its disagreeable odor, and the absence of proper means for good combustion. The odor which is produced chiefly at the commencement of the operation is produced by condensation of some of the products of the combustion upon a cold surface. It may be prevented in a great measure by previously heating the generator with another combustible. With regard to an efficacious burner, we do not know of any; Bunsen burners, which are generally preferred, afford hardly one-half the calorific power contained in the gas. The Parisian Company have directed a series of trials upon the calorific capacity of illuminating gas, which give sensibly the same results. Copper tubular boilers were employed of a capacity of *10 to 30 litres.* The heat was obtained from 2 Bunsen burners with flames from 20 to 25 centimetres high. The bottom of the boiler was placed so as to receive the flame at the height of 14 to 16 centimetres above the base.

The following table exhibits the results of the experiment: —

Temperature of the Water.	Time of Heating.	Expenditure of Gas.	Gas used for each 10c. of Heat.
Degrees.	Minutes.	Litres.	Litres.
10	. .	. .	. .
35	10	160	64
60	15	188	78
80	15	191	95
90	7	100	100
100	7	100	100
	54	739	

The boiler weighed 6.5 kilogs.; it contained 29.5 kilogs. of water. The number of calorific units produced was therefore $6.5 \times 9^{*} + 29.5 \times 90^{\dagger} = 2{,}713.5$. This corresponds to 3,700 units to the cubic metre of the gas. — *Van Nost. Mag.*

A NEW ROTARY PUMP.

This machine works very simply, and, after the manner of certain canals in the animal economy, imitating the vermicular or peristaltic movements of the intestines in their spontaneous motions which aid digestion. Revolving arms, turned by a crank, carry friction rollers, which, in rolling upon an elastic tube, press before them the liquid or gas that it contains, while the tube, regaining its form after the compression, exerts an aspiration proportioned to the elasticity of its sides. The plan is admirably adapted to all the requirements of stowing or transporting wines. For the use it offers the following advantages: —

1. The wine traverses the pump without shock (batter), — an important consideration, and belonging especially to this machine. While in ordinary pumps the wine sustains considerable beating and jolting, in this new apparatus it passes over as in a siphon, and flows, without encountering any obstacle, in an open canal.

2. The wine undergoes no alteration by its passage through the tube; long experience having proved that the rubber of which the tube is made cannot injure the most delicate wine.

3. There is no contact of the liquid with any oxidizable metallic surface, nor with greasy crated surfaces, such as, unfortunately, occur in all other present systems.

4. This pump yields a greater useful effect, in proportion to the

---

* *Calorific capacity of the copper.*

† Heat obtained from the gas.

force applied, than any other pump, whether reciprocating or rotary.

5. When it is desirable to empty the conducting tube, as when a cask has been filled, it is only necessary to reverse the motion of the pump, and the excess of wine is returned to the reservoir. This manœuvre, so simple and so advantageous, is impossible with any other system.

6. The tube is easily and promptly filled.

7. It serves to agitate the wine at the moment of sizing, by forcing through the siphon a powerful current of air.

8. Finally, this new wine-pump requires no care to keep it in order; it can be cleared with facility, or repaired, if necessary, without having recourse to a special workman; the replacing of the rubber tube, after very long use, being all that is necessary.

This pump was invented by MM. Mackintosh & Guibal, the celebrated rubber manufacturers. It has been extensively used by wine and beer manufacturers, who testify to its advantages. By using porcelain rings for ends and joinings, it may be used in pumping vinegar. If prepared rubber be substituted for the natural product, the pump will be very serviceable in raising petroleum and similar oils. — *Van Nost. Eng. Mag.*

A CONCRETE FROM GAS-LIME.

It is well known that gas companies turn out of their works a quantity of lime which has absorbed certain impurities from the crude gas. Hitherto, the only use found for this offensive smelling gas-lime has been the very limited one of spreading it on the land and at the roots of trees for killing insects hurtful to vegetation. Of course this is out of the question in the case of the large city gas-works, whose plant is too far removed from fields and orchards, and, although it is acknowledged that gas can be better purified by lime than by any other material, the trouble of removal of the waste product has forced the adoption of other methods which do not involve so much expense in carriage.

According to the London "Builder," Mr. Thomas Prideaux, of Sheffield, has been exhibiting blocks of concrete, mouldings, artificial stone-slabs for hearthstones, and other objects, all made from this refuse gas-lime; and as it is now the subject of a patent, and promises to furnish a useful material for building purposes, a short account of the results obtained up to this time may be useful. The gas-lime is ground under edge-stones, and presents at first a uniform green color. In this state it forms the raw material for making plaster or cement of various qualities and capabilities. According to the purpose required, it is used in this state, or it is calcined and reground and mixed with silicous matters. A wall may be covered with a smooth coat, which hardens free from cracks, for interiors; basements may be covered with a dry coat of cement, impervious, it is asserted, to damp, and quite obnoxious, be it remarked, to cockroaches. A hearthstone may be formed, and sets in a few days into a hard block of stone, as well as mantel-pieces and jambs, which, without any coloring-matter, present a neat and stone-like appearance.

It is remarkable that the peculiar odor of the gas-lime is no longer to be detected when the cement has set. The sulphur compounds are oxidized rapidly, and some of the adhesive qualities of the cement are no doubt due to the formation of calcium sulphate or plaster of Paris throughout the mass of the material in the process of hardening. A rubble-wall can be built up and plastered over to resist the action of water in the interval of a tide, as the properly prepared cement will set even under water. The latter property has induced Mr. Prideaux to propose its use for building sea-walls.

A number of houses in Sheffield, where trial has been made of this material, have been visited and inspected since its first application to walls, floors, and hearthstones, now about 12 months ago, and time only appears to tell in favor of its durability.

PRESERVATION OF CAST-IRON WATER-PIPES.

In 1858 the cast-iron pipes carrying the Cochituate Water from Boston to South Boston were treated with a preparation from coal tar, known as Dr. Smith's process, and the result has been so favorable that it has been permanently adopted by the Cochituate Water Board, and by the managers of other water works throughout the country, where the materials used for pipe is cast iron. The pipes laid in 1858 were taken up and examined after 10 years' use, and were found nearly free from rust or ochrous accretions. This coal-pitch varnish is applied substantially according to Dr. Smith's process, which is described as follows in the specifications: —

Every pipe and casting must be entirely free from dust, sand, or rust, when the varnish is applied.

The varnish or pitch is to be made from coal tar, distilled until all the naphtha is removed, the material deodorized, and the pitch reduced to about the consistency of wax or very thick molasses; pitch which becomes hard and brittle when cold will not answer for this use.

Pitch of the proper quality having been obtained, it must be heated in a suitable vessel, to a temperature of 300° Fahrenheit, and must be maintained at not less than that temperature during the dipping. As the material will deteriorate after a number of pipes have been dipped, fresh pitch must be frequently added, and at least 8 per cent. of heavy linseed oil must be added daily with the fresh pitch, and the vessel must be entirely emptied of the pitch and refilled with fresh material as often as may be necessary to insure the perfection of the process.

Each casting shall be kept immersed from 30 to 45 minutes, or until it attains the temperature of 300° Fahrenheit, and, if required by the engineer, shall be heated to such temperature as he may designate before it is dipped.

After the bath is completed, the castings will be removed and placed in such a position to drip that the thickness of the varnish shall be uniform.

The coating on the pipes and castings must be tenacious when cold, and not brittle, nor disposed to scale off; and when it shall appear to the inspector that the coating has not been satisfactorily applied, the pipe or casting shall be thoroughly scraped, cleaned, and recoated.

COATING FOR OUTSIDE WALLS.

The following coating for rough brick walls is used by the U. S. Government for painting light-houses, and it effectually prevents moisture from striking through: Take of fresh Rosendale cement 3 parts, and of clean, fine sand 1 part; mix with fresh water thoroughly. This gives a gray or granite color, dark or light, according to the color of the cement. If brick color is desired, add enough Venetian red to the mixture to produce the color. If a very light color is desired, lime may be used with the cement and sand. Care must be taken to have all the ingredients well mixed together. In applying the wash, the wall must be wet with clean fresh water; then follow immediately with the cement wash. This prevents the bricks from absorbing the water from the wash too rapidly, and gives time for the cement to set. The wash must be well stirred during the application. The mixture is to be made as thick as can be applied conveniently with a whitewash-brush. It is admirably suited for brick-work, fences, etc., but it cannot be used to advantage over paint or whitewash.

PRESERVATION OF STONES.

Dr. Robert, in the Paris "Les Mondes," maintains that the use of the black oxide of copper, and its salts, will effectually prevent change in stone. He shows that the decay of granite, marble, limestones, sandstones, and all natural building stones, is the combined effect of various causes, and that among these is a very minute lichen, the *Lepra antiquitatis*, which is one of the worst enemies of stone, and its action is to such an extent that, for instance, the beautiful marble sculptures of the well-known Parc de Versailles will, unless proper measures be taken for staying the process of decay, be unsightly and ugly masses of dirt, and quite irretrievably lost, as works of art, within the next 50 years. The author, taking as instances such buildings at Paris as the Bourbon Palace, the Palais du Corps Legislatif, the Mazarin Palace (*l'Institut*), the Mint, and others, points out that dust, spiders' webs, and the action of rain, combined with the minute lichen above alluded to, hasten the decay of stone, especially of those parts where any sculpture or ornamental carving promotes the deposition of dirt and dust. Various places and instances are cited of the application of oxide of copper and its salts, which places are open to inspection, and the length of time which has elapsed since such application seems to warrant the conclusion that these compounds act as preservatives of stone. In reference to granite, the author states that this stone is also, according to the experience of Egyptian engineers, far more readily affected by a moist climate than one would be led to believe. The obelisk of Luxor, brought from Upper Egypt to Paris, has become blanched and full of small cracks, during the 40 years it has stood on the Place de la Concorde; although 40 centuries had not perceptibly affected it as long as it was in Egypt. Granite in a moist climate becomes the seat of a minute cryptogamic plant, which greatly aids its destruction; and it is, moreover, a well-known fact, that the disintegration of this stone, which is composed of 3 separate minerals (quartz, mica, and feldspar), depends very greatly upon the thorough and intimate mixture, as well as the chemical composition, of these 3 ingredients, each of which, in a separate state, more easily withstands the influence of the weather.

PRESERVATION OF STONE.

The preservation of brown sandstone, which has become so popular as a building material, has also been the subject of experiment; and concrete building, as well as the manufacture of artificial stone, has been slowly but surely advancing.

Our readers will recollect some editorial remarks upon the subject of "Improved Building Materials," published not long since in this journal. The subject will bear further attention in connection with recent improvements.

There seems to be a general effort now making to produce cheaper and if possible better building materials than have hitherto been employed. Our exchanges from abroad, more especially those devoted to architectural topics, give us very encouraging accounts of the progress of concrete building. This style of building seems growing in favor, and is furnishing a very good class of dwellings at a very cheap rate.

We find also an account of a new kind of artificial stone, called the Victoria stone, which seems to have endured severe tests and to promise well.

It is the invention of a clergyman, Rev. H. Highton. The process by which it is made consists in mixing broken granite with hydraulic cement, and steeping the whole, when set, in a solution of silica. The granite used is the refuse of the quarries, and is broken up at the works. It is then mixed with Portland cement, in proportions of 4 of granite to 1 of cement, sufficient water being added to give it a pasty consistency. In this state it is placed in moulds, when it consolidates in about 4 days. When taken from the moulds it is placed for 2 days in a solution of silicate of soda, which completes the process.

The silicate solution is prepared in a peculiar manner, and upon it the success of the operation depends. The silicate of soda has the property of hardening any kind of concrete in which lime is a component. This substance has been hitherto too costly for general use in artificial stone manufacture, and it becomes caustic by the absorption of its silica, so that it attacks the hands of the workmen.

Mr. Highton produces his solution in the following manner. He uses a soft kind of stone, containing 25 per cent. of silica, found at Farnham, in Surrey, England. This stone readily dissolves in a cold caustic soda solution.

The solution of soda is placed in the tanks used for steeping the stone, and the Farnham stone is ground and added to the bath. The lime in the artificial blocks removes the silica from the solution, which in its turn takes up more silica from the Farnham stone, and so maintains its supply of silica, thus removing the objections above named. The process is extremely ingenious, and we are informed that flagging, sinks, mantels, coping, cap-stones, sills, etc., are produced by it. Finely cut mouldings are not successfully produced, and it seems better adapted to a heavier class of work.

In America also considerable improvement is observable in this field. A Brooklyn paper states that porcelain enamelled bricks are now produced by a firm in that city, of great beauty, both for outside and inside work, and at a cost not exceeding that of Philadelphia pressed bricks.—*Scientific American.*

ARTIFICIAL STONE. THE SOREL PROCESS.

There is no field of invention which to-day is more replete with general scientific and practical interest than that pertaining to the manufacture of artificial stone. While, in the working of iron, men have sought out means whereby it can be rapidly and cheaply converted into the forms required, the world has, to the present day, been content with working stone after the same general method used in the construction of the pyramids. The rudest of all materials is thus changed by immense labor into costly forms; and the attempts to obviate the necessity for this labor and expense have been confined to a very recent period.

The idea that stone could be cheaply produced by artificial means, and moulded to any form required, has gradually forced itself upon the minds of modern inventors, and has borne fruit in a large number of processes more or less practical and adapted to secure the end in view.

Very many of these processes have, however, failed to secure such results as to warrant their general adoption. Some require the steeping of the stones in some solution after they are moulded to remove or transform some contained material, or to add something which could not be advantageously added in earlier stages of the process. Among these is the celebrated Ransome process, which has not given uniformly satisfactory results.

Other sorts of artificial stones are sand concretes, made with cements of various degrees of hydraulicity, and many of them of such inferior quality as to render them utterly unreliable for use as building material.

The process invented by M. Sorel, a celebrated French chemist, *produces* results which we have never seen equalled by any other.

It has for its basis the use of oxychloride of magnesium, a new cement discovered by M. Sorel, who was also the discoverer of oxychloride of zinc. The process has been patented in this country, and the patent is owned by the Union Stone Co., of Boston, Mass., who apply it to the manufacture of all kinds of stone moulded in ornamental forms for building purposes. They also apply it to the manufacture of emery-wheels, needle-sharpeners, oil and water stones, soapstone register rings, and faces for sad-irons, etc. In short, they work any kind of stone by this process first disintegrating it by suitable mills and moulding it again into any form wished, and by the use of the cement named consolidating the mass to even greater strength than it originally possessed, without alteration of color or apparent texture.

We have now before us specimens of marble, sandstone, bluestone, etc., which look exactly like the original stone, yet which are even more dense and hard than the stone from which they are made. The marble, which is a beautiful specimen, having a fine crystalline fracture, was made of common marble-yard refuse. In fact, there is no sort of mineral solid material which the magnesium cement does not seem capable of uniting, and holding with great tenacity. The process of making stones by this method is as follows: Natural magnesite — carbonate of magnesia — is first calcined, which reduces it to the oxide of magnesium. In this state it is mixed dry in the proper proportion, by weight, with the powdered marble, quartz, sand, or whatever material forms the basis of the stone. It is then wetted with bittern water, which converts the oxide of magnesium into the oxychloride. The now semi-plastic mixture is rammed into moulds, where it speedily hardens sufficiently to be taken out and laid on skids. In 2 hours' time the stone is so hard that the heaviest rain will not wash the corners off, and in from a week to two weeks the stones may be marketed and used.

These stones are, according to good authority, capable of withstanding even more severe weather tests than natural stones. Tests made in Boston as to their strength are certified to have given better results than natural stone; and certainly the specimens we have, indicate that they are in no way inferior to the natural stones they severally represent.

The hydraulicity of magnesium salts has attracted the attention of several of the most eminent chemists in the world.

In a note recently read before the Academy of Sciences, in Paris, by M. Deville, he called attention to the action of water upon magnesia. A portion of a specimen of magnesia, prepared by calcining the chloride sent him several years previously by M. Denny, was kept constantly exposed to water under the taps of his laboratory. After a time it assumed a remarkable consistence, it could scratch marble, and, though subjected to atmospheric action for 6 years, it underwent no perceptible change.

The substance proved to be a crystallized hydrate. Subsequently, with magnesia prepared from the hydrate, he obtained similar results, and casts of medals after having been placed in water assumed the *appearance* of marble.

Magnesia, obtained by calcination of the chloride prepared by treatment of sea-water, though its hydraulicity is partially destroyed by calcining at a white heat, exhibits remarkable hydraulic qualities when brought to a red heat. Equal parts of chalk or marble and magnesia formed into a plastic mass, become hydrated and extremely hard when acted upon by water. A paste made from dolomite, calcined below a red heat and powdered, forms, under water, a stone of extraordinary hardness.

The experiments of M. Deville show that to the hydraulicity of magnesia is due the union of the particles of chalk or marble in forming a compact, homogeneous stone, and numerous obvious applications of this property of magnesia in the arts will readily suggest themselves.

M. Frémy, in his published researches on hydraulic cements, attributes the setting of hydraulic lime, first, to the hydration of the aluminate of lime, and, second, to the reaction of the hydrate of lime upon the silicate of lime, and the silicates of alumina and lime.

It is evident from these observations that the oxychloride of magnesium is a cement of great power and durability, and that as an hydraulic cement it ranks among the best known to modern science. Its application to artificial stone manufacture, we think, solves the problem of how to make such stones of proper density, durability, strength, and capability of taking a high polish. If we may credit the statements in regard to cost of manufacture, there seems no reason why stones of this kind should not be able to more than compete with cut stones of any variety and for any purpose. — *Scientific American.*

THE DARIEN CANAL SURVEY.

The United States government expedition sent to survey the Darien Isthmus has returned. Owing to unavoidable causes the expedition did not reach the Isthmus till about April 1. They immediately landed at Caledonia Bay and made a careful exploration of the route proposed by Dr. Cullen. They found the lowest mountain pass to be over 600 feet above the sea level. About the first of May the party proceeded to explore the San Blas route from Mandinga Bay, on the Atlantic, to Chepo, at the southern end of Panama Bay, on the Pacific. This route, Com. Selfridge thinks, is available. The rainy season commenced before he landed at San Blas, and all the country was flooded with water, yet from his reconnoissance he thinks that a careful survey will develop a route whereby a canal can be made with only 27 miles of cutting. We are pleased to see that he is already ordered to reorganize his expedition for a renewal of the survey next winter. The route favored by Com. Selfridge is the narrowest point of the whole Isthmus. It is said that the tidal waters of the two oceans there come regularly within 7 miles of each other, and it is there that the tradition exists that the Indians and buccaneers drew their canoes across. It was there, too, that Vasco Nuñez di Balboa landed, and journeying toward the Pacific first saw the waters of that ocean from the heights south-east of Panama. The harbors on both sides are good. This route was brought before the public by Mr. Oliphant in a lecture before the British Geographical Society. It was reconnoitred for F. M. Kelly, Esq., of New York, in 1864, and, while having many favorable points, was reported against on account of a proposed tunnel, the engineers at the same time stating that they believed a better route could be found.

One of the great objections urged to this part of the Isthmus has been supposed unhealthiness. Com. Selfridge reports that his men had good health, and only one died. This from a crew numbering fully 600 men does not indicate a very unhealthy climate.

As Com. Selfridge is to proceed again to the Isthmus next winter, and we suppose not only make a thorough survey of the San Blas, but also of the Panama route, some definite information may at last be expected as to an American interoceanic canal. Then, too, we notice that Congress is about to appropriate 35,000 dollars for the survey of the Tehuantepec line.

SUEZ CANAL.

The report of M. de Lesseps, presented to the shareholders at Paris, states that 1,600,000 dollars will be required this year to complete or improve the works. The total number of vessels passed through the canal, from the day of its opening to the 15th of March, was 209.

In the report of Captain Richards, R.N., and Lieut. Col. Clark, C.B., sent by the English government to examine the canal, with reference to the future utility of the same to the English marine, we observe that by 52 accurate sections, taken at different points, the canal is found to be essentially completed according to the original, or rather modified, designs of the company, and "is, at the present moment, undeniably a navigable canal for vessels of considerable draft and tonnage."

It appears that the company intend, without delay, to reduce the sharpness of certain curves, and widen the bed at these points to 130 feet on the floor; also to make the channel at Port Said 30 feet deep. This will require the removal of about 451,000 cubic yards of earth.

It is also intended to mark the banks of the canal by conspicuous beacons at each mile, and to provide posts or bollards for securing ships or heaving them off at every tenth of a mile, and to mark the limits of 16 feet water on each side by buoys placed about 400 yards apart.

According to the same report, no difficulty is to be apprehended in regard to the harbor of Port Said, either with reference to keeping the channel open or in its approach by vessels.

So, also, as to the silting up of the canal by drifting sand, the permanence of the fresh-water canal, now 10 years old, is conclusive evidence upon this point.

The authors of this report further conclude that the use of this canal will be decidedly advantageous to several classes of war vessels and to the mercantile marine.—*Journal Franklin Institute.*

SURVEY OF THE ISTHMUS OF DARIEN FOR AN INTEROCEANIC CANAL.

The expedition for the survey of the Isthmus of Darien to ascertain the practicability of a route for the interoceanic canal, under the command of Commander T. O. Selfridge, U.S.N., sailed from New York in the latter part of January, 1870.

During 6 months of the year, a heavy sea breaks all along the Atlantic border of the Isthmus, and, consequently, the necessity of a good harbor narrows very much the field of research, which a knowledge of the orology of the Isthmus also limits to a corresponding degree. There are but 3 harbors on the Atlantic coast of the Isthmus, adapted for the terminus of a canal,—the Gulf of San Blas, Caledonia Bay, and the Gulf of Uroba or Darien. The first 2 are magnificent bays, easy of access, and entirely protected from the north winds and heavy swell. The Cordilleras Lloranes skirt the coast at distances varying from 3 to 8 miles, without a break, except at the northern and southern extremities, while the Chiman range, crossing the Isthmus, indicates that in the central portion will be found the greatest amount of mountain area.

The survey was begun at Caledonia Bay in the latter part of February. The whole face of the country is covered with a primeval forest, impenetrable from the thick undergrowth but by slow and laborious cutting, through which the surveyor struggles with his compass and level, seeing neither the sky above nor the country around. In these circumstances it was soon evident to the commander of the expedition, that the most practical as well as the most expeditious method would be to carry on the survey up the different water-courses. This would give at all times the lowest level, the rivers would lead to passes in the mountains did such exist, and the best results would be obtained in the shortest space of time. As the work proceeded, should any route indicate a level adapted for the proposed line, a more exhaustive survey would be undertaken.

Reconnoissances with the barometer were made up all the streams emptying into Caledonia Bay, including the Aglamate, Aglaseniqua, and Washington Rivers. While these were in progress, a reconnoissance in force was made over the mountains to the Pacific slope down the Sucubti, until the villages of the mountain Indians, the Sucubti tribe, were reached. Here a treaty was made by the commander with them, similar to one with the coast Indians, and the exertions made to show them that we had not come to occupy the country, but merely to look at it, coupled with rigid orders not to molest their property, enabled us at all times to remain on the most friendly terms.

The result of these explorations failed to exhibit any signs of a pass, and the line up the Aglaseniqua River, thence over the mountains, giving the lowest average level, was selected as the one to be surveyed.

A line of levels was successfully carried from the sea over the dividing range, at an altitude of 1200 feet, and down to the Sucubti, at a point about 3 miles below its sources, where an altitude of 560 feet was obtained. A series of careful observations were made with both the aneroid and mercurial barometers, at the different bench-marks, whose height was already determined by the spirit-level. They resulted in showing that the aneroid barometer was totally unreliable, being often 100 feet in error, while the extreme deviation of the mercurial barometer was never more than 30 feet, and the average not more than 12 feet from the correct height. The height of the Sucubti, by spirit-level 560 feet, was evidence sufficient that no pass below that altitude existed in the divide. This river with its tributaries, the Napsati and Asnati, drain a large area of country, of which its bed must necessarily represent the lowest level. Careful observations with the mercurial barometer were made down the Sucubti to its junction with the Chucunagua, at which was found an altitude of 159 feet. 10 miles down the Chucunagua an altitude of 99 feet was obtained.

In all observations with the barometer a standard was also noted at the sea-shore.

All idea of a pass in the divide being exploded, there remained the sole test of a tunnel to decide upon the impracticability of this route. Allowing the largest error ever obtained in our experiments in the barometrical heights of the Sucubti, taking 30 feet as the depth of our canal, and conceding that at 200 feet tunnelling is more economical than open cutting, there will be found a distance of 10 miles from an altitude of 200 feet on the Atlantic slope to a corresponding one on the Pacific, or, in other words, a tunnel of this length would be necessary. The country in the vicinity of the Sassordi River presenting favorable indications from the sea, a similar exploration and survey was carried on from Sassordi harbor, some 10 miles north of the previous surveys. This was continued up the Sassordi River across the divide to the Morti, but a like result was obtained, requiring a tunnel of 8 miles in length to span the mountain area.

The northern portion of the Isthmus, from the Gulf of San Blas to the Pacific, forms the narrowest portion of the continent, but 30 miles in width. The shortness of this line, the appearance of the interior from the sea, and the magnificent harbor, pointed it out as the proper field for still further explorations. Work was accordingly begun about the 1st of May, and though the rainy season had begun, the favorable indications of this line filled all with enthusiasm to push ahead in spite of the hardships and obstacles arising from an inclement season. The line of levels was carried up the Mandinga, the largest river emptying into the Atlantic between the Chagres and the Atrato, and crossed the divide at an altitude of 1100 feet.

It was continued in a S.S.E. direction down the Pacific slope, till, at a distance run by level of 23 miles from the sea, it met, at the junction of the Marmoni and San Jose Rivers, with the survey of Mr. Kelley's in 1864, *whose* engineers ran a line of levels from the Pacific up the Marmoni to this point. This survey in connection with Mr. Kelley's gives a line of spirit-levels from ocean to ocean that, following the bed of streams which flow transversely across the isthmus, present the lowest possible profile. The result showed a mountain area of 10 miles that would require to be tunnelled, an undertaking too costly to be profitable, if within the limits of engineering, while the other portions of this route present the most favorable aspects.

The southern portion of the Isthmus still remains to be explored. The government propose to continue these surveys the coming season, which will be carried up the valley of the Tuyra, across the divide to the Cacarica Lake, not far from the mouths of the Atrato. This region was visited by Hellert, an experienced German traveller, in 1845, who reported the divide not over 200 feet, but this is very unreliable, as he was so unfortunate as to lose his instruments before it was reached. The expedition returned to New York in July, and though not successful in finding a proper route, have reaped a full reward for their labors in the clearing away of all doubt from 3 separate routes, and their elimination in the future from the field of research.

CENTRAL SHAFT HOOSAC TUNNEL.

At last, after years of toil, and at a cost of close upon half a million of dollars, the great central shaft of the Hoosac has reached the grade of the tunnel; 1,030 feet below the natural surface. This shaft is elliptical, the transverse diameter being 27 feet and the conjugate 15 feet, passing the entire depth through a compact mica-slate formation intermixed at intervals with white quartz. At the commencement of the present contract with the Messrs. Shanly, there required to be done 447 feet. This has been accomplished since June 1, 1869, say in 15 months; giving a monthly average of 29.8 feet. The largest month's work was 38 feet. At intervals of about 18 feet are floors of heavy timbers, supported by "hitches" cut in the rock, connected by ladders, in case of accident to the hoisting apparatus, and forming supports for the wooden "guides," in which the cross-head travels, under which is suspended the boiler-plate iron bucket, of a capacity of about 400 gallons. The work has been impeded slightly by water, of which the shaft makes nearly 3 inches per hour. To raise this water, an engine of 60 horse-power is constantly working, pumping all the water which collects as far down as 650 feet, caught in tanks by sloping "drip roofs." Below this, the water on the bottom has been hoisted in the iron bucket, a bucketful being sent up by the miners whenever the quantity became inconvenient. Now, the shaft being at grade, a "sump" will be sunk and a water-bucket with bottom valve used, thus avoiding the tedious task of bailing into the bucket by hand.

Workmen are now employed trimming the sides of the shaft, and preparing the "guides" for a wooden cage to be substituted for the bucket so soon as the "headings," east and west, at the bottom, are sufficiently advanced to use rock cars, when the rock will be raised to the top direct from the headings, cars and all.

The shaft being at grade necessitates, probably, the most delicate and responsible professional act an engineer may ever expect to meet, it being necessary to lay down a line less than 27 feet in length at the bottom of a dripping dark shaft 1,030 feet deep, so that both ends of the line being produced shall coincide with the terminal points of the tunnel, each being distant over 12,000 feet from the centre of the shaft. To increase the initial difficulty, the top of the shaft is on the summit of a rugged mountain, from 1,500 to 1,800 feet above the grade of the tunnel at its termini. It is no light responsibility to assume charge of this operation. The State of Massachusetts has had manufactured a colossal transit instrument, of the most elaborate and perfect construction, costing 3,000 dollars. The most accurately verified lines have been laid down over the mountain, extending long distances beyond in both directions to the tops of neighboring mountains. By the accuracy of this instrument and its manipulation, the line of 27 feet (the transverse diameter of the shaft) will be permanently defined, requiring wonderful exactness, and from its extremities the "plummet" alone can reach the bottom of the shaft. These plummets must of necessity be weighty and beautifully poised, and will require to be suspended in oil to produce perfect rest and protection from the faintest vibration of the air. The most delicate cords, consistent with strength, must be used to suspend them, and after all is done that science can suggest (being perfect as to theory) any intelligent mind can understand how delicate and fraught with danger is the practical part of the operation to the engineer, and what grave effects the slightest error would produce on so small a base as 27 feet. It is quite possible the motion of the earth may affect the plummets more or less; but this point has not yet been thoroughly investigated.

THE HOOSAC TUNNEL.

The Hoosac Tunnel, it is reported, is now progressing at the rate of 10 feet a day, — 4 feet from the west end, and 6 feet from the east end. The central shaft is complete; its depth to the floor of the tunnel is 1,030 feet. Work at the new headings is already begun. The tunnel has been excavated 11,765 feet at both portals, that is, 6,946 feet at east side, and 4,819 feet on the west side. — *Van Nost. Eng. Mag.*

INTERNATIONAL COMMUNICATION.

Mr. Bessemer supplies the following description of his invention for improving steam communication by the construction of a suspended chamber. He says: "The experimental vessel is of only 153 tons' measurement, and, although much too small to attain the best results, is, nevertheless, quite large enough to make the Channel passage, and prove, beyond question, the practicability, *or otherwise, of the* mechanical principle involved. Not the least of the advantages which the new system of ocean transit offers is the shortness of the time and the small amount of capital required to put it into operation at every seaport in the kingdom. For instance, 2 steamers, fitted with means for the most luxurious accommodation of passengers, in vessels of great size, and having sufficient engine power to cross the Channel in 60 to 65 minutes, and fully adequate to carry the entire passenger traffic, could be put on the station within 8 or 9 months from the date of order, at a cost not exceeding £130,000. The commercial advantages of such a system, as compared with those proposals which would require some £8,000,000 or £10,000,000 sterling, and several years to execute, will be readily appreciated by the public, the more so as my system will be subjected to the test of actual trial before a shilling need be expended by the public upon it. The proposed new system does not contemplate the employment of ships that shall be motionless except in the direction of their course; for the waves would strike on such a vessel as on a rock, and dash themselves over her as they sometimes leap the Eddystone. It does not attempt to arrive at the end desired simply by construction of ships or rafts of vast size, for it is well known that the largest ships that have ever been built roll frightfully in the Channel in bad weather; nor is it by any new and untried external form of the vessel, involving new problems in navigation; on the contrary, my system in no way whatever interferes with the external form or with the sailing qualities and safety of the vessel, the whole difference being in the internal arrangements of the ship, and is based on the well-known law that all bodies which revolve or roll, in so doing, move about a centre where there is no motion, and all beams that vibrate move also about a centre, from which point the distance moved through by any part of the beam is as the distance from this central point. Now, therefore, if we make the centres, about which the vessel pitches and rolls, coincident with the axes on which the saloon is suspended by suitable mechanism, and provided with a heavy counterbalance weight beneath the centre of gravity, the tendency of this weight will be at all times to keep the saloon poised on the centre of the vessel's motion, and therefore free from pitching or rolling, its floor remaining always quiet and horizontal, while the vessel itself may be pitching and rolling about the centre of suspension. The most convenient form for such a saloon is circular, surmounted by a large dome, lighted at the top with glass. It is proposed to make this circular saloon of 50 feet in diameter, and 28 feet in height internally, having a gallery extending entirely around its interior at about 9 feet from the floor. A continuous couch around this gallery would accommodate 60 persons, while about 70 others would find a similar accommodation below, independently of the large space afforded by the floor of the saloon. This large and lofty apartment, although much smaller, would present somewhat the general appearance of the new reading-room at the British Museum. It would be supplied with plenty of cool, fresh air from below, which would pass off through the glass louvres in the dome.

The saloon would be entirely separated from the rest of the vessel by water-tight bulkheads, thus cutting off all unpleasant smells from the engines and boilers. The suspension is so arranged that the vibration of the engines and propeller cannot be transmitted to the saloon, which is also relieved from the constant thud of the waves striking against the sides of the vessel, because there is no contact between the ship's sides and the walls of the saloon. Suitable ante-rooms leading from the saloon are also provided for invalids, etc. The general plan also embraces the construction of raised deck platforms, so arranged that those who prefer the open air may have beneath them a steady platform free from the rolling and pitching motion of the vessel. From the cursory view here given of the mode in which I propose to secure at all times a perfectly steady platform on board ship, the scientific reader will, doubtless, see many grave difficulties. He will probably ask, How do you propose that passengers shall pass from the reeling deck backward and forward at all times into your quiet, immovable saloon? How can you prevent a pendulous motion of the saloon from being set up by the variation in position of the centre, which will occur unless your vessel rolls and pitches at all times actually on a point coincident with the point where you have established your centre of suspension? How can you prevent the saloon from being put in motion by people moving in it from side to side? My reply to these anticipated inquiries is simply that each of them, and many others beside, have been presented to my mind in full force during the elaboration of my plans, and each has been so fully met and provided for as to offer not the slightest obstacle to that success which I believe my little ship, the 'Enterprise,' will fully establish when put to sea, until which time I must beg the critic to suspend his judgment." — *Van Nost. Eng. Mag.*

ACTION OF SEA-WATER ON THE METALLIC FASTENINGS OF SHIPS.

We extract from the proceedings of the Institution of Naval Architects, London, the following short but comprehensive paper read by William Poole King at a recent meeting. Of course the facts stated apply equally to all similar fastenings employed in stationary floating structures and docks: —

"The small fastenings of ships are trenails, iron bolts, and copper metal bolts. Each have their advantages and defects.

"The trenail, generally an oak bar of 1¼ inch to 1½ inch in diameter, is a cheap fastening. It carries no galvanic influence from the outside copper on the bottom of a ship to create rust in the iron work within, and is vulgarly considered the very stamina and constitution of a ship; still it must strike every one not blinded by routine that nothing can be more absurd than to prepare oak timbers square, and cut out all the sap from them, at the cost of about a crown per foot cubic, and then drill this expensive timber *full of holes from* 1¼ inch to 1½ inch wide, in order to drive in trenails, and thus take at least half the strength out of the timber.

"About seaports, where old ships are broken up, many old timbers are met with in the fields spotted with two large holes in about every foot of their length; decay will be observed in all these holes, caused by the woody fibre being bruised by trenail-driving, for bruised fibre gives nourishment to dry-rot fungus. Trenails having been squeezed in driving become rotten and weak, cease to hold the planks to the timbers with firmness, get bent, and allow a ship to bend and yield throughout its whole frame; this is called hogging and sagging.

"Iron bolts and spikes are the cheapest strength that can be put into a ship. They are the handiest fastenings that a workman can use; and a little rusting allows a very small fastening to take a very strong hold; in fact, it is everything that could be wished did it but last without decay.

"In a ship iron bolts are always damp and always rust; rust frets away woody fibre. Iron bolts, too, always contain a portion of sulphur, which gets converted into sulphuric acid, which decomposes both the salts always found in oak, and also salt water, never absent at sea. A ring of decomposed wood surrounds every bolt; and as the salts and oxide of iron are not prejudicial to fungus growth, dry-rot fungus takes possession of the ring of decomposed wood.

"Iron bolts are inadmissible in the bottoms of ships sheathed with copper; the salt water acting on so large an extent of copper sends such quantities of electricity through the iron bolt that the substance of the bolt is carried away, and a vacancy, which lets in leaking-water, is left in its place.

"Copper bolts and cupreous metal bolts are more expensive and less strong than iron, but, unlike iron bolts, instead of fretting the wood in which they are inserted, actually preserve it, for the verdigris which is formed on the copper bolt poisons the dry-rot fungus. But the copper bolt has the serious disadvantage of having little hold on the wood through which it passes, and this little holdfast becomes less after the wood has shrunk with age, so that the only value of the fastening power of copper metal bolts is left in the riveted ends of the bolt, and when this end breaks off, as it frequently does in 9 or 10 years, by getting crystallized, the fastening is of no value at all.

"Trenails are too cheap and useful, as plugs for keeping out leaking-water, to be given up in wooden-ship construction; but the disadvantage of their unwieldy size, boring through and destroying everything, should be reduced as much as possible. Trenails should be always of the best materials, creosoted to prevent the introduction of dry-rot, kept small in size to prevent their doing immoderate harm to the worthier parts of the ship, and driven short to obviate the destruction of timbers and floors.

"It is agreed on all sides that iron bolts must never be used in the wake of copper sheathing. Indeed, to insure the durability of the structure of a ship iron bolts should never be driven at all, except in situations where they can be removed and replaced.

"Covering iron bolts with zinc (called galvanizing) does not protect the iron from rusting, as the acid of the oak surrounding the bolt soon dissolves off the zinc cover, and corrosion proceeds with all its concomitant evils.

"A large quantity of copper metal fastening is now required in first-class ships. It is expensive. Let us inquire how the greatest strength, at the lowest cost, can be got from it.

"The screw form, I believe, will be found the strongest and cheapest method for the use of copper metal. This form gives a secure hold, and does not injure the wood if the pitch of the screw be kept high; that is, the threads of the screw be kept far apart. I have been accustomed to use screws 7 inches long instead of trenails.

"The bolt is moulded in threads, 3 turns in an inch, cut in a three-quarters inch bolt of Prince's metal, weighing 13½ oz., and costing 9d. This screwed through a 3-inch plank penetrates the timbers 4 inches and requires no rivet, as I have tried to start a deal end from a 4-inch thick piece of oak secured in this manner, with a strain of 36 cwt. suspended, without having been able to produce the least separation of the deal from the oak. The necessity of a through fastening does not exist, as the timber can be secured to the ceiling by a similar screw to keep it exactly in place; thus a long length of metal bolt is saved, the timber but slightly wounded, and the strength of the frame immeasurably increased.

"For larger fastenings, such as those for securing timbers and floors to iron riders, I have used a thread one-eighth inch in height, placed round outside a seven-eighths inch Prince's metal bolt, instead of cutting into the body of the bolt, in order to preserve its lateral strength and rigidity. The turns of the screw are 3 in 2 inches; a length of 14 inches weighs 3 pounds, and costs 2s. 6d. I found a strain of 49 cwt. was barely sufficient to tear this screw through a 3-inch deck deal end, and of course a longer length screwed into oak would require a heavier strain for its removal.

"Pure copper cannot be cast into a screw for any strength, and therefore I have used Prince's metal (a mixture of 16 oz. copper, 3 oz. zinc, and ½ oz. tin.) This mixture runs into every sinuosity of the casting-mould, is so tough that it will bend more than double cold, and I believe will not crystallize and break when it has grown old."

THE "CAPTAIN."

The following are the particulars and dimensions of the "Captain," whose recent loss has startled the American as well as the British public. H.B.M.S. "Captain;" designer, Capt. Cowper Coles, R.N.; builders, Messrs. Laird Brothers, Birkenhead, G. B., 1870.

Hull 320 feet long; 53 feet 8 inches beam, 24 feet 9½ inches depth. Tonnage 4,272 B.M. Plating, 8, 7 and 6 inch on hull, 1 and 1½ inch on spar-deck, 10 and 9 inch on turrets, with teak backing. Forecastle and poop-decks 11 feet high, connected by hurricane-deck 24 feet wide, with iron deck-house between turrets; 2 25-ton 600-pounder guns. Deck 6 feet above water. Ship rig, "tripod" masts; 33,000 square feet of canvas; fitted with 7 boats and 2 steam launches. Engines, 2 pairs trunk engines, 900 N.H.P., surface condensers; 2 screws, 16 feet diameter each. Speed on measured mile, full power 14.239 knots; half-power 11,697. Complement of officers and men, about 500. — *Journal Franklin Institute.*

CONSTRUCTION OF THE "CAPTAIN."

The particulars of the sinking of the "Captain" leave hardly any doubt upon the faults of construction to which her loss must be attributed. Although of 1,000 tons less burden than the "Monarch," she had the same heavy armament and thick plating as that great ship, with enormous iron masts, large spars, and an unprecedentedly extensive area of canvas. The "Monarch" has a freeboard of 14 feet; the "Captain," in accordance with the system of her designer, was built only 9 feet above the water. Thus she was in the first place especially liable to heel beyond the centre of gravity, in consequence of the great weight of the spars, sails, and turrets above deck, and in the second place particularly apt to ship heavy seas on account of the lowness of her freeboard. Being struck by a squall on the port side, she gave a sudden lurch, so that the tops of the turrets were under water, and the wind got so powerful a purchase against the under part of the broad hurricane-deck, which extends from bows to stern above the turrets, that she was unable to right herself, and was actually overset by the weight of her masts. She was a more dangerous vessel than the "Monarch," first, in having disproportionately heavy spars and too much canvas; secondly, in having too low a sea-board; thirdly, in having a wide hurricane-deck where the "Monarch" has only a bridge; fourthly, in carrying too much weight above the water-line in proportion to her draught. Her loss seems to settle the principle that low freeboard and heavily armed turrets, however applicable to vessels of the monitor class without masts, cannot be safely combined in sea-going vessels designed to spread canvas. — *N. Y. Tribune.*

WINDWARD GREAT-CIRCLE SAILING.

Mr. J. T. Towson, secretary of the Liverpool Local Marine Board, read a paper at the meeting of the British Association, "On Windward Great-Circle Sailing," illustrated by the Transatlantic yacht race. Mr. Towson referred to the tables for facilitating great-circle sailing constructed by him, and published by the Admiralty 24 years since, in which he pointed out the value of windward great-circle sailing. The other modification of this sailing had been brought into successful use; but windward sailing, although it appeared most simple, had been generally misunderstood by practical men. Some had obtained charts having great-circle routes laid down. If they were driven from this track by adverse winds, they returned as soon as the wind would permit them, not perceiving that when they had quitted one great circle there was another great circle, which was their nearest route. Others imagined that this sailing consisted in going a certain number of miles to the northward. The rule was simple. "Find the great-circle course, and put the ship on that tack which is the nearer to the great-circle course. In January last he was invited by Mr. Ashbury to prepare sailing directions for the Cambria yacht, which he did. These directions were shown by a chart. It consisted of the great-circle course, corrected for variation, for every part of the Atlantic it was probable that a vessel should pass. All the mariner had to do was to ascertain his approximate position, and then he would find by inspection how to keep the ship's head by compass. The distance from the place of destination was also given by another chart containing the position of both yachts at noon for each day. Mr. Towson showed that the "Cambria" saved the race by superior navigation. This sailing gave the greatest advantage when the distance of longitude was greatest; and thus the "Cambria" attained all the advantage that this sailing could afford in the first 5 days, which was about 110 miles; afterwards the superior power for an ocean race possessed by the "Dauntless" prevailed, and reduced this advantage to a minimum.

THE CABLE SYSTEM OF RIVER NAVIGATION IN GERMANY.

The Frankfort correspondent of the Chicago "Republican," writes that the cable system of navigation is, at the present time, making rapid progress in Germany. This system prevails on the whole course of the Elbe through the kingdom of Saxony, and to some extent in the neighborhood of Magdeburg, and its extension into the interior of Bohemia on the one hand, and to Hamburg on the other, is projected, and is expected to be completed in a short time. On the Danube and its affluents the laying of a wire cable by the Danubian Steamship Navigation Company (Donau-Dampf-schiff farthgeselschaft) is being quickly and energetically prosecuted. The laying of one along the Rhine in Westphalia has already been completed. It is also intended to make this fresh invention available for the smaller streams of Germany, as, for instance, on the Saale and the Unstrut, for which the civil engineer, Opel, of Merseburg, a little while ago, recommended the laying of a wire cable instead of the proposed construction of a towing-path. This system of cable navigation (either by ropes or chains) is likewise cheaper than the use of towing-paths, and by this method, also, the possessors of land and other property on the banks of rivers are spared many inconveniences and unpleasantnesses, which are otherwise unavoidable. Opel has also shown the superiority which cable steamers possess over paddle-wheel steamers, since the former cause no ripple. This system has likewise an advantage in point of economy, since a steamer working on a chain or rope can make use of from 90 to 94 per cent. of its steam power, while a paddle-wheel steamer can only use 60 per cent., and even, in case of a strong current, only 30 per cent. As a rule, says the "Bearbeiter," the passenger boat with a 45 horse-power engine must discontinue its voyage at high water, while a towing steamer with a 14 horse-power engine holds the navigation open. The cable system of navigation can go on undisturbed in general so long as the sluices remain in good working order. While, on account of the inundation, etc., the towing-path is inaccessible, such hindrances, on the contrary, form no obstacle to the steamer on the cable; or, at most, it only requires somewhat more coal, if the current be strong. The most important argument, however, in favor of the introduction of this system of navigation by means of a cable laid along the bed of the river lies in the fact that a certain plan can be held; the failure of navigation lies principally in this, that the condition of the weather, or the negligence of the captain, may cause an unpunctual arrival of the cargo at its place of destination. The journey from Magdeburg to Hamburg, by means of the cable system, can be accomplished in 3 days, while now often 4 weeks are required. Tremendous as the difference is, it is, nevertheless, given as a fact by the above-named paper. There are two difficulties which present obstacles to the introduction of this system on some streams; for instance, on the Rhone and Saone, in France, this method of river navigation is not possible, because those rivers convey with them too great a quantity of sand, and thus clog up the cable. The other difficulty is the sharp bending of streams, as in the case of the Saale; but the impediment can be overcome to some extent by attaching fewer boats to the tugging steamer. The "Bearbeiter" makes the remark: "If we cannot succeed so far as to see 30 boats dragged one after the other on the Saale, as on the Seine, we must, for the present, be satisfied to transport 3 or 4." On the Oder, also, this system is about to be adopted; but this river has, in one place, only a depth of 15 inches; and it is, therefore, necessary to build the vessel according to the nature of the stream. On the Elbe, with from 17 to 18 inches of depth, it succeeds well, and the investment has realized from 9 to 12 per cent. In the Saale, at low water, there is a depth of 28 inches, which, however, soon deepens to from 36 to 40 inches, which is a circumstance much in favor of the above system.

THE GUATTARI ATMOSPHERIC TELEGRAPH.

This new invention is stated to consist of certain arrangements and combinations of apparatus whereby ordinary air, compressed and passed through a tube, is utilized as a means of communicating intelligence from one given point to another, effecting the same object as the electric telegraph. The principal portion of the apparatus consists of a reservoir or air-vessel which is charged or filled with air compressed to any desired degree according to the initial velocity or force which it is requisite the movements of the air employed should possess. A double-action compression-pump, or any other suitable mechanism, may be employed to charge the reservoir or air-vessel and to sustain the pressure to the required degree. The reservoir or air-vessel is connected by means of a tube or pipe with a writing-apparatus of any suitable description, and such as are well known and understood, especially in connection with electro-telegraphy; the tube or pipe being provided with a cork by which more or less force may be given to the current of air whereby the writing-mechanism is actuated. In order to regulate the signals, a governor or piston, actuated by hand, is employed, by which pulsations or movements of the air in the tube or pipe are transmitted through a valve which is arranged therein, the currents actuating a lever connected with the writing-apparatus. For the purpose of giving or receiving signals, the before-mentioned tube or pipe is connected with a conducting tube or pipe constructed of any suitable material, and which is so arranged that communication can be established between the air reservoir or vessel, and the writing-engine which is placed at the receiving-station, or *vice versa*, by means of stopcocks which are worked by hand. An indicator is employed to show the force of the current of air passing through the transmitting tube or pipe. Similar arrangements are, of course, placed and employed at each end of communication. By means of this invention it is stated that intelligence and signals can be transmitted to any distance; any of the known receiving and recording instruments capable of being used in connection therewith being employed. It is obvious that any number of conducting-tubes may be employed, the requisite currents or pulsations of air therein being produced as before mentioned. The Guattari system claims to be more simple than the electric system, both in point of construction and continuous use, for whereas in the latter case it is necessary to use the electric battery and all its accessories, by the former ordinary atmospheric air compressed will perform similar functions. It is also claimed for it that it is free from atmospheric influences, which it is well known materially disturb the electric telegraph on the occasion of storms; and that the tube employed as the medium for conducting the air would not be subjected to accidents like the ordinary wires, and would therefore necessarily last longer, and thus prove much more economical. We understood, also, that it is so simple that any person may learn in a few hours how to use and work it with the greatest ease, as compared with the electric system; it is calculated that the machinery necessary to work this system could be produced at about one-half the producing and annual working cost of the electric system. The Royal Scientific Institute of Naples has already awarded to Signor Guattari a gold medal in recognition of what they consider an important invention, adding a graceful tribute on its presentation to the effect that it was the only gold medal which the Institute had ever awarded. The following experiments were made on Monday, 11th July, 1870: —

1. Transmission by atmospheric compression by means of the large machine, obtaining answers by impulsion and repulsion, — Signor Guattari having at present but one machine.

2. System of impulsion and repulsion by a naval apparatus, which may be used with 5 different derivations or branches.

3. Universal telegraphy, namely, dispatch telegrams to one or more stations at the same time without the aid of the transmitting-machine, or the necessity of the sender remaining fixed to any one point. — *Nature.*

THE NEW CABLE BETWEEN ENGLAND AND FRANCE.

The new cable for the Submarine Telegraph Company, to be laid from Beechy Head to Cape Antifer, near Havre, a distance of about 70 miles, has been commenced at Mr. Henley's works, at North Woolwich, and will soon be completed. It forms a large, massive cable, and will be one of the largest yet manufactured. The core consists of 6 insulated conductors, wound and served in the ordinary manner; each conductor is a strand of 7 wires, weighing 107 pounds per nautical mile, and insulated with 3 coatings of Chatterton's compound, and 3 of gutta-percha to the weight of about 150 pounds per mile. The severed core is sheathed externally with 12 No. O.B.B. galvanized iron wires, protected with 2 servings of tarred hemp and bituminous compound. The shore ends have a similar core, but are sheathed with 12 No. 0000 B.B. galvanized iron wires, protected with 2 servings of hemp and compound. This is the first time wire of such enormous diameter has been used for submarine cables. Land lines for this cable are being erected between London and Beechy Head, and Havre and Paris, so that the new line will be an independent one, and will tend to obviate, if not prevent, the delays which have frequently occurred in the transmission of messages between London and Paris, arising chiefly from a pressure of business. In future any breakage which may take place in the old and new lines will be quickly repaired, because, under the authority given lately, the company will conduct repairs with their own repairing ship, instead of employing a tug as hitherto. — *Van Nostrand's Eng. Mag.*

PROFESSOR HENRY OF THE SMITHSONIAN INSTITUTE ON LIGHTNING RODS.

In answer to a letter of inquiry as to the best method of erecting and constructing lightning rods, Professor Henry gives the following instructions: —

1. The rod should consist of round iron of about one inch in *diameter; its* parts, throughout the *whole* length, should be in

perfect metallic continuity, by being secured together by coupling ferrules.

2. To secure it from rust the rod should be coated with black paint, itself a good conductor.

3. It should terminate in a single platinum point.

4. The shorter and more direct the course of the rod to the earth the better; bendings should be rounded, and not formed in acute angles.

5. It should be fastened to the building by iron eyes, and may be insulated from these by cylinders of glass (I don't, however, consider the latter of much importance).

6. The rod should be connected with the earth in the most perfect manner possible, and nothing is better for this purpose than to place it in metallic contact with the gas-pipes, or, better, the water-pipes of the city. This connection may be made by a ribbon of copper or iron soldered to the end of the rod at one of its extremities, and wrapped around the pipe at the other. If a connection of this kind is impracticable, the rod should be continued horizontally to the nearest well, and then turned vertically downward until the end enters the water as deep as its lowest level. The horizontal part of the rod may be buried in a stratum of pounded charcoal and ashes. The rod should be placed, in preference, on the west side of the building. A rod of this kind may be put up by an ordinary blacksmith. The rod in question is in accordance with our latest knowledge of all the facts of electricity. Attempted improvements on it are worthless, and, as a general thing, are proposed by those who are but slightly acquainted with the subject.

OCEAN TELEGRAPHY.

Captain Rowett at the meeting of the British Association read a paper "On Ocean Telegraphy." He discussed at length the various properties of the hemp telegraph cable, and to the satisfaction of the section cleared away the generally received objections to light cables, by giving several illustrations, which indisputably proved to the audience how perfectly still was the bottom of the ocean, and even waters of moderate depths, in which the light hempen cable would lie in security. He gave also some striking illustrations of the disadvantages of mixing iron wire with hemp, and made a polite appeal to the numerous ladies present whether their linen was not seriously damaged by contact with iron. Hemp was only a coarser kind of the same material, and would be destroyed by the oxide of iron. He maintained also, and gave excellent specimens of the fact, that hemp can be preserved for any length of time, and even the salt of the sea preserves the fibre, whilst on the other hand it destroys iron. Captain Rowett made a forcible appeal for the adoption of the hemp cable, which would be half the cost of cables now used, and so do great service to the millions who desire to have ocean telegraphy within their reach; and as there was no possibility of doing justice to the subject at a meeting of a section of the Association where so much business had to be done in so little time, he offered to discuss the subject at length at any time with those interested in the matter. Some remarks were made, not only of approval, but the opposite views which had been always entertained were now entirely removed.

ASPHALTE TUBES FOR UNDERGROUND LINES.

Of what material the tubes used to protect and form a subway for underground wires shall be made, has long been an open question. M. Collette, of the Netherlands Telegraph Administration, has submitted the following interesting facts with regard to the employment of asphalte.

In 1865, a trial line, nearly 3,000 yards in length, was laid in asphalte tubes in the streets of Amsterdam. These tubes have each an interior diameter of 3 inches (about 75 millimetres), and are 7 feet (2 metres 134 millimetres) in length. They are jointed to each other by the aid of muffles of short pieces of tubing 4 inches in interior diameter, the interstices being run with bitumen. The laying was executed without the least difficulty. Only 6 copper wires, covered with a double coat of gutta-percha, were, in 1865, introduced into the asphalte tubes; but, 2 years after, this number was augmented to 25 wires. It is from this occasion that we have been able to ascertain that the wires withdrawn from the tubes, after having been worked during 2 years, were in such perfect condition that they were replaced with the 19 new wires. The asphalte tubes, since they were laid, have 3 times been uninjured by accidents which cast-iron tubes would have been unable to resist, and, doubtless, in breaking, would have injured the wires.

Five years have elapsed since the laying in Holland of the first line in asphalte tubes, and, hitherto, scientific men have not been deceived in their expectations. Also the Netherlands Telegraph Administration has not hesitated to follow the path dictated by experience. In January of the present year a length of 10½ miles of underground lines was laid in asphalte tubes. The maximum number of wires introduced into tubes, having 3 inches internal diameter, amounted to 40.

The tubes are chiefly manufactured at Hamburg, and the prices are as follows: for tubes 7 feet in length and 3 inches in diameter, one dollar per length; for those having the same length and 2 inches in diameter, the cost per length, including muffles for jointing, is about 75 cents. Tubes having other dimensions have not yet been constructed in Holland.

THE CHASSEPOT AND THE NEEDLE-GUN.

An account is published in the "Birmingham Gazette" of the two weapons which are in the hands of the belligerents on the Continent. The "Zundnadelgewehr," or needle-gun, of the Prussian service, to which the victories of the Prussian arms in 1866 have been attributed, appears to have been originally patented in England, as a muzzle-loader, in 1831, by a Mr. Moser, of Kennington. The invention came before its time. Its cold reception in England drove the patentee to seek foreign patronage for his novelty, and Prussia was lucky enough to appreciate and to adopt the new weapon. Dreysa, a gunmaker of Sommaler, applied the breech-loading principle to Moser's patent, and thus amended, the arm 10 years later was in 1848 introduced into the Prussian service. The principle, briefly stated, is the driving of a pointed piston or "needle," by the action of a spiral spring (such as is used in the manufacture of children's toy-guns) into a small case of fulminate, contained in and situated between the powder and the bullet of a single cartridge. In the action of opening the breech, the spiral spring is set by the trigger, and thus the trigger, when pulled, releases into operation the spiral spring, which, in its turn, forces the needle into the cartridge and fires the piece. Upon this oldest form of the Prussian needle-gun improvements have been made, the chief effects of which have been a reduction of the mechanism of the needle of 1848, and a general lightening of the entire piece. None of these alterations, however, have touched those two apparent evils in the whole form of this arm which militated against its adoption by England in 1850. These are the positions of the fulminate in the interior of the cartridge and the looseness of mechanism, involving possibility of the escape of gas round the needle and at the base of the plunger. To these two particular points France mainly devoted herself in seeking a superior needle-rifle to that of Prussia. In the Chassepot such an improved arm has been found. A triple wad of vulcanized India-rubber, placed round the axis of the plunger, with a steel plate, forms a cushion to receive the force of the rebound and is intended to render the breech gas-tight, but has been found in practice only partially adapted to that object. An ingenious arrangement of notches on the outer girder of iron, before described, enables the gun to be placed at half-cock. The needle is lighter and smaller than in the Prussian gun, and, above all, the cartridge contains its fulminate at the base of the powder, instead of at the base of the bullet. A vacuum left when the gun is charged, between the base of the cartridge and the front of the plunger, is intended to effect the combustion and removal of any portion of the cartridge-case that may remain after firing. As compared with the Prussian gun, this weapon possesses, besides the specific improvements mentioned, other advantages of superior manufacture and finish. Its cartridge, besides admitting the altogether different principle of firing, contains a larger charge of powder than the Prussian cartridge, with a smaller bullet, which leaves a manifest advantage in carrying to the French weapon; and the fact that the Prussian bullet is purposely made so small as not to touch the barrel in its passage, while the French bullet is of the ordinary size to fit the rifle-barrel, would point to the conclusion that the Prussian marksman is at a disadvantage over the Frenchman in respect to his arm. The number of times of firing per minute is about the same in both cases. The cost of the French weapon considerably exceeds that of the Prussian, and the Chassepot is, in addition, a more difficult gun to make. To all the comparative information which has been published about the French and Prussian guns must be added the following from the "Journal du Peuple:" At 500 metres the Prussian weapon gives only negative results, while at 1,000 the Chassepot, in the hands of good marksmen, hits the target with great force. We call attention to this point, for in the war of large bodies of sharp-shooters (the only system which we ought to adopt), an arm which is not reliable over 500 metres cannot reach the reserves of the first front, which escapes the effect of the enemy's fire. The drawbacks of large bullets have been noticed, the principle being this, that with needle-guns the firing is rapid, and, therefore, a great amount of powder is burnt; consequently, the cartridge-box must be well stored. Now there is in the weight of ammunition allotted to a foot soldier a total which cannot be exceeded, namely, 10 pounds. What will happen? With that weight of cartridges the Frenchman will have twice as many shots to fire as the Prussian. Nothing is more difficult than to replace, during fire, the ammunition by a fresh distribution. Thus, the retreat of a division may depend on its finding itself in face of an enemy which has still 20 or 30 cartridges a head to fire. It will be seen that the winning of a battle may depend on the projectile adopted. — *Van Nost. Eng. Mag.*

PROJECTILES.

An extremely satisfactory result, as far as the navy is concerned, was lately obtained at Shoeburyness. A target representing a portion of the deck of an iron-clad ship, protected by 1-inch iron plates, was fired at by the 9-inch muzzle-loading rifled gun, the projectile being a Palliser shell, the charge the full battering one of 43 pounds, and the distance 100 yards. The target was so arranged that the projectile struck at an angle of about 8 degrees from the horizontal, so as to represent the angle of incidence of a shot fired direct at about 2,000 yards, or that of a projectile fired at 100 yards from a higher level; such, for instance, as that of the "Monarch's" battery as compared with the "Captain's." It was found that at this angle the projectile did not enter the ship, but, after ploughing up the woodwork of the deck, ricochetted off it, and went away screaming and whistling up into the air until lost from sight. One of the disadvantages urged against a low freeboard is thus disposed of as far as 9-inch guns are concerned. The "Monarch," however, is armed with 12-inch guns, and it would be interesting to ascertain whether the above results would hold good in the case of the larger calibre. It seems desirable also to ascertain the actual angle at which a projectile fired horizontally will penetrate a ship's deck protected with as much iron as is admissible in its construction. Ships' decks may often be subjected to a plunging fire from elevated batteries such as those on Stradden Heights or Gibraltar. — *Van Nostrand's Eng. Mag.*

PRUSSIAN NEEDLE-GUN.

The alteration of the Prussian needle-gun has been sanctioned by the king, in consequence of which 2 or 3,000,000 of rifles in the possession of this government will be remodelled. The improvements introduced aim at simplifying the loading, and increasing the force and range of the ball. For this purpose the caoutchouc ring of the Chassepot has been adopted, which, helping to close the breach by spontaneous action, renders it unnecessary to press the valves tightly down. In addition to this the weight of the ball has been reduced from 31 to 21 grammes, which, with the charge remaining at 4.9 grammes as formerly, considerably augments the propelling force. To fit the reduced ball for the old barrel the *zund-speigel* has been proportionately enlarged, a proceeding the practicability of which was proved by a similar alteration, adopted some time ago, and further attested by a year's experiments with the weapon in its present latest form. On the needle-gun being first taken into favor, in 1841, it had a ball of 15.43 millimetres, but the heaviness and consequent want of speed observable in the missile caused it soon to be reduced to 13.6 millimetres, which size has now been further diminished to 12 millimetres. The total weight of the new cartridge is 32 grammes, instead of 40, as heretofore, so that the soldier will henceforth carry 95 instead of 75 cartridges, without experiencing an additional burden. Besides this, the needle is now made to move in a narrow hole, into which it fits exactly, instead of the wider one of the old gun, and a piece of oiled paper is placed at the bottom of the cartridge to clean the needle after each discharge, and serve some other purposes of minor importance. — *Van Nostrand.*

PHOTOGRAPHY APPLIED TO MILITARY PURPOSES.

A writer in the "Nature," of July 21st, dwells upon the use made of photography by the English military authorities. Three establishments have been organized in connection with the army, in which photography is extensively practised.

Pictures are taken to illustrate the positions taken by a soldier in different drill systems; of pack mules, to illustrate the manner of packing for the benefit of the India armies; in short, photographs are used whenever mere descriptions would be prolix and ambiguous.

Great use is also made of this art in recording the results of experiments in gunnery; these photographs are made by the carbon process. — *Editor.*

NEW ARMS.

Sir Joseph Whitworth, Bart., at the meeting of the British Association, had had diagrams prepared to illustrate the Chassepot, the *Prussian, the Enfield,* and the Whitworth bullets. The Chassepot was 2.44 calibre, the Prussian 2.01, the Enfield 1.93, and the Whitworth 3.00. At an elevation of 58 minutes, the range of the Chassepot was 500 yards, the Prussian 206 yards, the Enfield 295 yards, and the Whitworth 345 yards. The two most important elements in long ranges were a full charge of powder and sufficient length of bullet. In both these respects the Enfield ammunition was sadly deficient, and he had been urging the War Office authorities ever since 1857 to substitute the 45-inch bore. The velocity of the Chassepot bullet was much greater at the commencement of its flight and much less at the end; thus, its penetration was comparatively small at long ranges.

Mr. E. J. Reed, C.B., said it appeared to be universally admitted that a small-bore rifle was a long-range weapon; and that if troops were armed with a large-bore or short-range weapon they would be subjected to a murderous and destructive fire before their rifles could be brought within range of the enemy armed with the small-bore rifle. It was clear that the small-bore or long-range rifle was the only effective weapon for military warfare to make that warfare effective.

BALLOONS FOR WAR PURPOSES.

The experiments made at Woolwich by balloons inflated at the Royal Arsenal Gas Works have, on the authority of the London "Artisan," shown that a height of 100 fathoms, at a horizontal distance of 600 fathoms from an enemy, would enable the observers to secure a wide expanse of view. The balloons with which experiments were made at Woolwich were held by 2 new cords fastened to the network, and terminated at 2 different points on the ground, to give greater stability to the balloon, and to provide against one cord snapping, or being cut by the enemy's fire. By the new system of military telegraphy for field service, and by means of wagons at present being placed in store in the Royal Arsenal, lines of telegraph can be carried through the air from the earth several miles distant. The wire can be paid out as fast as the balloon travels, so that if a captive balloon should break away, communication could be kept up with it for 6 miles; or 2 or more balloons can be sent up, and kept in telegraphic communication with each other by means of similar lines, so that telegraphic operations can be made from the balloon to head-quarters, and thence to the base of operations.

By means of these new military telegraphic appliances the most rapid intelligence, and consequent speedy word of command, can be given. In sieges, war balloons are useful in giving information of depots, points of attack, batteries, inner intrenchments, the explosion of magazines in marshes, to spy out ambuscades that may be in waiting, to rally columns, and to telegraph points of assembly on attack. The observing officers were enabled to survey an area of 30 square miles. It was found that by practice great skill can be attained in judging of distances, and the relative position of masses of troops; while more minute details could be subsequently obtained at leisure by field-glasses as to the position of mountain gorges, passes, limits of woods, and the course of streams. The trials hitherto made have been chiefly carried on by professional aeronauts with hired balloons; and it is believed that the British Government have at the present time no war balloons in store.

The result of the observations of Captain Brackenbury and Captain Noble, sent out from Woolwich on behalf of the English Government to the respective seats of war, together with trials and other sources of information, will, it is believed, result in war balloons being manufactured in the Royal Arsenal, and that officers of royal engineers, from generals downwards, will be trained in their use.

THE GREAT SUBMARINE BLAST IN THE HARBOR OF SAN FRANCISCO.

It is well known that extended preparations have been making for several months, under the direction of Col. Van Schmidt, C.E., to remove what is known as Blossom Rock, the most dangerous obstruction in the magnificent harbor of San Francisco.

That so important an engineering work should have been brought to so successful a conclusion reflects great credit upon the skill of Col. Van Schmidt, and the particulars of this feat of submarine blasting will be interesting to our readers.

A careful survey of the rock was made at the outset in order to ascertain the irregularities of its surface. This being done, and plans being drawn, a coffer-dam was constructed around a portion of the rock to be removed, and moored by means of a scow loaded down with heavy stones.

The water was stopped from entering the dam by sand-bags placed about its base, and an iron turret was erected within it. This turret was then sunk 3 feet into the rock and cemented fast. A platform 56 feet long and 20 feet wide was then erected, and an engine and hoisting apparatus placed thereon, together with a building in which to lodge the workmen and prepare their meals.

The plan of excavation was to scoop out the interior of the rock, leaving an external shell of sufficient thickness to resist the pressure of the surrounding and superincumbent water, and finally to shatter and scatter the shell by blasting. The thickness of the shell was about 6 feet.

Pillars of rock were left to sustain the shell, and when these were removed they were replaced by timber supports. The space excavated measured in the clear 140 by 50 feet, and it is estimated that about 40,000 cubic feet of stone were taken out. The shape of the surface of the rock was nearly oval, but for a distance of about 120 feet it sloped very little. The height of the highest pillar inside was 29 feet, and the lowest 4 feet. The stone was a porous sandstone. When struck with a hammer it fell to pieces readily, and revealed a series of seams running through it. There was no mixture of slate or granite, or any of the harbor kinds of stone in it.

Of the 23 tons of powder used, about half was contained in English ale casks, double-coated with a heavy pitch varnish inside and outside so as to be water-proof. The other half of the powder was in 7 boiler tanks of wrought iron, firmly bolted, the largest measuring 8 feet in length and 2 feet in diameter. The barrels were placed close to the side of the excavation, near the junction of the arch or roof with the floor, so as to blow away the arch from the lowest point of the excavation reached. They were placed resting on their sides. The 7 boilers were laid through the centre of the chamber, the largest in the middle, where the roof was highest. This disposition was made to equalize the force on each part of the rock. A perforated piece of gas-pipe, 2½ feet in length, charged with fine gunpowder, ran into each barrel from the end, with a piece 6 feet long into the boilers, charged in the same way. These different tubes were connected with insulated electric wires, which passed from one barrel to another, the end in each tube consisting of a fulminating cartridge.

The insulated electric wires connecting the barrels were encased in gutta-percha. When the powder was arranged in the excavation, and the connections made secure, this wire was drawn up through a tube in the shaft, and placed on board a bark situated about 1,000 feet from the rock. Here it was connected with an electric battery. The coffer-dam was then removed, and the water permitted to fill up the excavation, and so act as a tamping.

It being understood that the blast would be fired on the 23d of April, a very large concourse of people gathered to witness it. Everything appears to have worked properly, and the explosion threw a column of water and rock, 100 feet in diameter, 100 feet into the air. It is believed the operation has been entirely successful, and that the rock will give no further trouble.

The method employed seems very ingenious, and is, so far as we are aware, entirely novel. — *Scientific American.*

REMOVAL OF THE HELL-GATE OBSTRUCTIONS.

The work of removing these noted obstructions to navigation is continued unremittingly night and day. Eight "galleries" or chambers have been commenced. These run in various directions under the reef, all converging to a common centre at the point of beginning. They are named after distinguished men. Those furthest advanced are "Grant," "Sherman," "Humphries." They all front the great excavation, which is 60 by 100 feet in size, and 30 feet from the mean low-water mark to the floor line. "Grant" gallery has been pierced to a distance of 32 feet directly under the most formidable spur of the reef. These tunnels are to be extended a distance of 200 feet, and are from 8 to 10 feet in diameter. The rock is very hard — mostly gneiss. The blasting charges are one-quarter, one-half, 1 and 2 pounds respectively, contained in pasteboard tubes well wrapped in glazed gutta-percha cloth, tarred at the ends, with safety-fuse, all water-proof. 30 or 40 of these are discharged at the same time, a gong being previously sounded to draw off the workmen.

Huge logs, interlaced with iron bands, form "curtains," which are hung at the opening of each tunnelling to prevent the detached rock from being hurled into the air without. The force is so terrific, however, that these ponderous curtains are often swung out 8 or 10 feet. Great steam derricks elevate the refuse, and steam pumps lift out the water. Daily observations are taken to guide the work. A miniature levee keeps off the water on the river side. A temporary platform extends out over the reef, from which a fine view of the wild, rushing tides is afforded. Even when but about a depth of 2 feet of water is flowing over the "hog's back," its force is so great as to sweep a strong man instantly off his feet. This gigantic enterprise must proceed very slowly, and require years for its successful completion.

EXPLOSIVE POWER OF NITRO-GLYCERINE.

We condense from the "American Chemist" the following upon the above subject: —

A measure containing 1 cubic foot will hold 796 ounces of blasting-powder, and 997.1 ounces of water; or, in other words, the specific gravity of blasting-powder, as it is used, is about 0.8. This, of course, takes in the interstices, which are filled with air, but as we do not use the powder in a solid lump, this is, for practical purposes, the specific gravity of blasting-powder. Now, the specific gravity of nitro-glycerine is 1.6. Therefore, bulk for bulk, if the explosive power were the same in a given mass, as prepared for blasting, the nitro-glycerine would have twice the power.

In reality the following are the volumes of gas generated by each respectively in explosion: —

One volume of powder, which is considered as most effective, produces: —

Carbonic acid gas	221.4 vols.
Nitrogen,	74.6 vols.
Therefore one volume becomes	296.0 vols.

Of another kind of powder, which explodes with the gases at a lower temperature, one volume produces: —

Carbonic oxide,	391 vols.
Nitrogen,	66 vols.
One volume becomes	457 vols.

One volume of nitro-glycerine produces: —

Carbonic acid gas,	469 vols.
Water at 100 C.,	554 vols.
Oxygen,	39 vols.
Nitrogen,	236 vols.
One volume becomes	1,298 vols.

These volumes are given at the temperature 0 degree C.; at the temperature of explosion, they will be about 5 times greater, or about 10,607 times the original volume of the explosive, or about 10 times as large a production of mixed gases for the nitro-glycerine as for the gunpowder which produces mixed gases in largest amount.

Still 13 times is claimed by the advocates of nitro-glycerine. If this is so, the discrepancy between the temperature of the explosion must be greater than here assumed.

LITHOFRACTEUR.

Analysis shows that "Lithofracteur," as well as dynamite, consists of a mixture of a silicious base with nitro-glycerine. The proportion of glycerine appears to be that which the base can take up without becoming sensibly moist. — *Dresdner Gewerbevereins-Zeitung.*

In the "Centralblatt," of Oct. 15, can be found a discussion of the merits of the above. Its exact composition appears to be

Nitro-glycerine,	52
Silicious base,	30
Coal,	12
Saltpetre,	4
Sulphur,	2

DUALIN.

Professor Mowbray, who superintends the manufacture of nitro-glycerine at North Adams, for the Hoosac Tunnel, writes to the "Springfield Republican" in regard to the explosion at Worcester, Mass. He finds that dualin consists of 60 per cent. mono-nitro-glycerine and 40 per cent. of sawdust.

The mono-nitro-glycerine is exceedingly unsafe to manufacture, to use, or to transport; it is not nearly as destructive as the tri-nitro-glycerine and yet is far more dangerous to handle. There are 3 different nitro-glycerines. Of these 2 are the most dangerous and not as powerful as the third, which is not dangerous but very difficult to explode, and when exploded is 33 per cent. more powerful in its effects than either of the 2 others.

Trials were made with dualin at the Hoosac Tunnel, and were complete failures. Only about 50 per cent. of results as compared with the nitro-glycerine in use at the tunnel were obtained, and the miners were asphyxiated by the cyanogen given off. — *Editor.*

Dualin is a brownish-yellow powder, similar in appearance to Virginia tobacco. In the open air it burns without an explosion, and in a confined space it acts like gunpowder.

It is proof against shocks, it does not decompose, or bake together, can be readily put into cartridges, and can be used as well in warm as in cold, in dry as in wet, places. Its strength is 4 to 10 times greater than the common powder, and greater than that of dynamite.

Dualin consists of cellulose, nitro-cellulose, *nitro-stärke nitro-mannit* and nitro-glycerine, mixed in different proportions according to required strength.

We believe that dualin, with its present quality and with its present price, has every prospect of being useful in mining operations, especially in coal-mining, when with its great, but yet not too quickly, working power, it can rival powder. — *Bergeist.*

In the "Centralblatt," of July, can be found a long account of this new explosive, taken from the "Deutsche Industrie Zeitung." — *Editor.*

COMPARATIVE EFFECTS OF GUNPOWDER AND GUN-COTTON.

A number of experiments have been recently carried out by the officers of the Royal Engineers at Chatham to test the comparative effects of gunpowder and gun-cotton in various operations. The experiments were all made under the direction of Colonel W. O. Lenox, C.B., Y.C., Instructor in Field Fortifications at the school of Military Engineering, assisted by a number of other officers. The experiments were attended by a large muster of officers of the garrison, besides those of the engineering corps, and also by Major-General J. L. Brownrigg, C.B., the commandant of the garrison; Colonel W. Pray, Colonel Graham, C.B., Y.C., Colonel Fiser, Colonel Lovell, commanding Royal Engineers; Colonel the Hon. H. F. Keare, Deputy Adjutant-General Royal Engineers; Colonel Clarke, etc. Mr. F. A. Abel, chemist to the War Department, was also present, and assisted in some of the experiments with gun-cotton. The experiments commenced with explosions of gunpowder and gun-cotton directed against a double stockade of balks of timber 14 inches square, 3 feet 6 inches apart, and sunk 3 feet in the earth, each line braced together by strong cross-pieces. A charge of 200 pounds of gunpowder, in bags merely laid at the foot of the stockade, untamped, was first exploded. It forced a large gap in the front stockade, but, though partially shattered, the second row of timber would have presented a formidable obstacle to an attacking party if defended by a few resolute men. Portions of the timber were hurled through the air to some distance. A charge of 80 pounds of gun-cotton was next laid in bags at the foot of the stockade, some distance from the former explosion. This also was untamped. It was fired by a detonating fuse. There was a terrific explosion, and an almost perfectly clear breach was made through both rows of timber, practicable for an attacking party to get through. The effect was very much superior to that of the 200 pounds of gunpowder. Immense pieces of timber were hurled through the air to a great distance, mostly in the rear of the stockade. Not so wide an extent of timber appeared to be shaken as by the first explosion, but the work was more completely done; the results, indeed, were extraordinary. Experiments were also made by exploding discs of gun-cotton against single balks of timber, to show what effect would be produced if timber bridges had to be destroyed. Four balks of timber, about 16 inches square, were sunk in the ground some feet apart in a square, and braced together by thick pieces of plank. A "necklace" of small discs of gun-cotton was formed (about 68 in number); this was doubled and placed half round one of the timbers. The explosion of this string of discs tore away the wood for some depth, 4 inches or more on one side of the balk, but did not break it, though the massive timber was much rent. Three or four larger discs were then exploded on one side of the timber, and tore out a large portion of the wood. A single "necklace" of small discs, 65 in number, and weighing 2½ pounds, was then placed round another balk, quite encircling it. When exploded this tore out the wood all round to some depth. Then 12 of the larger discs, weighing 4 pounds 2 ounces, were hung on nails on three sides of the timber, and exploded. The explosion was very powerful, and the large balk was cut in two; snapping off where the gun-cotton had been attached, but falling on the side where there had been no discs and partially splitting on that side. The spectators cheered at this decisive proof of the value of gun-cotton for this special purpose. All these experiments appeared to be very satisfactory. At that part of the lines in front of St. Mary's Barracks, a number of mines and galleries had been excavated and charged with gunpowder or gun-cotton. One mine had a charge of 500 pounds of gunpowder; a second similar mine was charged with 200 pounds of gun-cotton. Two smaller mines were charged respectively with 21.6 pounds of gunpowder and 8.6 pounds of gun-cotton. These mines were successively exploded by means of an electric current. In the larger mines the powder appeared to be the most effective agent. In the explosion of the 200 pounds' charge of gun-cotton, a peculiar effect was produced; first, there was the eruption of brown clay and smoke, and then a large flame, produced by the ignition of the gaseous products of the explosion. The officers then proceeded to the old Engineer Depot, near St. Mary's Convict prison, and walls which are to be removed were experimented upon; they are 18 inches thick; charges of gun-cotton ranging from 2 pounds to 3½ pounds were exploded against these walls, with satisfactory results, making breaches in them. The officers then returned to the scene of the mines, where two long galleries had been prepared, one charged with 240 pounds of gunpowder, the other with 96 pounds of gun-cotton. These charges were exploded. The object was to ascertain if it is practicable to form trenches in this *manner,* instead of throwing them up while exposed to the enemy. It was thought by some officers that the explosion would throw the earth up on either side in such a manner as to form a trench; but the result was not so; the earth was thrown up in a mass, and no trench was formed in which men could get under cover at once. The experiments were of great interest and highly satisfactory.— *Van. Nos. Eng. Mag.*

COMPARISON OF NATURAL AND ARTIFICIAL ICE.

The French company *Messageries impériales*, wishing to ascertain what kind of ice would be preferable for their vessels navigating the Suez Canal, caused experiments to be made, under identical circumstances, with several varieties, with the following results: Time required to melt 200 pounds of ice:—

Natural ice of Switzerland,	107 hours.
" " Norway,	115 "
" " Massachusetts,	138 "
Artificial ice, Carré's machine,	130 "
" " Tellier's machine,	144 "

If these experiments were conducted with accuracy, they would seem to prove that artificial ice would have the preference over the natural production of our lakes and rivers for transportation on shipboard, and for refrigerating mixtures. One series of experiments is scarcely sufficient to settle a question of this importance.

THE TELLIER ICE-MACHINE.

The manufacture of ice by artificial processes is steadily gaining ground and favor. During the last summer it has received a powerful impulse from the exorbitant prices asked and unwillingly paid for ice in this and southern cities, in which this article has become so much a necessity that people will pay almost any price rather than be deprived of it. In this city its price reached 2 cents per pound before the close of summer, and in one southern city, we are informed by a correspondent, it reached 5 cents per pound.

It is not probable that such exceptionable prices can be maintained during ensuing seasons; but even at the prices at which we may reasonably hope to purchase ice, or at least such prices as must be demanded for ice shipped to southern towns, it is now demonstrated it can be produced artificially at large profits and in any required quantity.

Two machines have been brought prominently into public notice, each employing the same volatile material as an absorbent, conveyer, and radiator of heat, and being in some sort rivals in the effort to secure public favor. We allude to those known as the Carré and the Tellier ice-machines. The volatile agent in *both is generally* ammonia, and, though differing widely in detail and cost of construction, they employ the same general principle in the conversion of water into ice.

To the general reader it may be well to state here that the fundamental principle upon which machines of this kind operate is the absorption of heat from surrounding bodies by an expanding substance, the conveying of this heat to some other absorbing body, into which the heat is caused to radiate by the condensation of the conveying substance by mechanical compression, the passing back of the conveying body to extract another modicum of heat from the body to be cooled or frozen, and so on till the desired degree of refrigeration is reached.

It is a physical law with which perhaps some of our readers are not familiar, that the capacity of any substance for heat—that is, its power to absorb heat, and hold it in the latent or insensible state — increases with its expansion and decreases with its condensation. A substance which at ordinary temperatures is a permanent gas will, when compressed, become sensibly heated; the latent heat which it holds, under ordinary circumstances, being rendered sensible by condensation. If while in this state the sensible heat be taken up by some other substance and conveyed away, the gas in expanding will seize the heat from surrounding bodies, thus reducing their temperature. The gas, on being again compressed, will yield this heat to any substance having a lower temperature. The proportion of heat absorbed during expansion, and emitted under pressure, increases with the degree of alternate condensation and expansion.

Ammonia, which is a gas of ordinary temperatures, becomes a liquid under a pressure of from 9 to 13 atmospheres, according to the temperature of the surrounding air, emitting a large amount of heat in so doing, which amount must be restored to it before it can expand to its original volume. On this account it is admirably fitted for use in refrigerating apparatus.

The Tellier machine, besides differing much from the Carré machine in matters of detail, differs from it in its action,—the condensation of the ammonia being in the latter effected entirely by mechanical compression, while in the former the strong affinity of ammonia for water is used in the collection of the gas, the latter being separated from the water again by distillation.

In the Tellier machine the liquefied ammonia is first received into a strong cylinder, for convenience of transportation. This cylinder being attached to suitable pipes connected with the machine, the opening of certain cocks allows the ammonia to escape into a distributer or a cylinder connected by pipes with the congealer. The congealer is a square box divided into compartments by hollow metallic partitions, the compartments being filled with the water to be frozen, or they may be filled with a solution of chloride of calcium or salt water, in which are placed metallic moulds containing the water to be frozen. The latter is most convenient when very large cakes are desired.

The ammonia, passing from the distributer into the hollow metallic partitions of the congealer, expands into a gas, absorbing in its *expansion a large* amount of heat from the fluid contained in the compartments. It is then drawn from the congealer by the pump and forced back again into the distributer in a condensed form. During the process of condensation it gives off its heat to water surrounding a coil through which the gas is passed on its way to the distributer, from which it again passes to the congealer, and so on, being used over and over without material loss.

It will be obvious that any other volatile liquid besides ammonia might be used in the same manner as a conveyer of heat. It is further obvious that by replacing the hollow partitions of the congealer by a series of bent pipes, air might be cooled if forced through the series of pipes by a fan. This is precisely what is done with an apparatus made by the proprietors of the Tellier machine, the cool air being supplied to vaults and rooms used for preserving fruits, packing meats, etc., and for purposes of ventilation in churches and public buildings in hot weather. There is, we are informed, no difficulty in reducing and maintaining the temperature to any desired point down to 32° Fah., and the air, being supplied in a dry state, is much better adapted to keeping fruits and meats than when charged with vapor from its passage through ice.—*Scientific American.*

NEW SUGAR-REFINING PROCESS.

In the sugar-house of Messrs. A. Sommier & Co., of Paris, 200,000 pounds of raw sugar have for a year past been daily refined according to a process invented by Boivin and Loiseau. The process is founded upon the use of a new body, the sucrate of the hydro-carbonate of lime, which the inventor employs for the purification of raw sugar instead of blood, bone-black, etc. For the preparation of this compound, milk of lime is made from the waste sweet liquors of the refinery, and enough syrup added to give the mixture 20° Baumé. This is well agitated and run through a cooler until the temperature sinks to 68° Fah. From the agitators the liquid flows into vats, where it is partially saturated with carbonic acid; the gas is passed through until the desired precipitate of sugar, lime, and carbonate of lime settles as a gelatinous mass. After the purifying agent has been thus prepared, it is applied in the following manner: —

The raw sugar is dissolved in a cylindrical pan, similar to a vacuum pan, under diminished pressure. Revolving buckets carry it into receivers over the boilers, and from these it is permitted to flow into the boilers, where it comes in contact with the sucro-carbonate of lime previously introduced, in a quantity proportional to the percentage of raw sugar. They generally take about 650 gallons of the gelatinous sucro-carbonate to 8,000 pounds of sugar. Water is added if necessary; the whole is boiled, and in this way the solution and clarification are simultaneously accomplished. One great advantage of the operation is that when syrup is boiled in presence of lime, ammonia is evolved, all glucose is decomposed, and anything likely to produce fermentation is destroyed.

The syrup from the boilers is filtered, the excess of lime separated by carbonic acid, and it is further concentrated and finished in the usual manner. The slimy residues and precipitates are squeezed out in filter presses until they contain no trace of sugar, and can be thrown away. The wash-water is used in the preparation of new material. The advantages of this new process are, that it does away with the use of blood, which is offensive, difficult to obtain, and the soluble constituents of which are finally concentrated in the molasses.

It also yields greatly improved products, which are brighter in color and better in grain. The third crystallization of this process is better than the second in the old way. The expense is, if anything, less, certainly not more. The process has been patented in the United States.

APPLICATION OF DIFFUSION IN SUGAR-REFINERIES.

Abbé Moigno states that in the years 1869–70 the number of sugar-houses in which the principle of diffusion or dialysis was employed for refining sugar was 82, and that 31 additional works are in process of construction; so that in 1871 there will be 113 refineries in which practical application will be made on a large scale of Graham's important law. The crystallizable sugar passes through membranes, while the impurities, being uncrystallizable, are retained in the tank where the original solution was made. The fact that so many large houses employ this method would seem to indicate its entire practicability.

PHOTOGRAPHY ON WOOD.

Anthony's "Photographic Bulletin" gives the following process by A. J. Searing for photographing on wood for engraving purposes: —

"The block on which the picture is to be made is first dampened with water, then whitened with enamel, rubbed from the surface of good enamelled visiting-cards. Rub gently, removing only the enamel, after which it is brushed smooth with a moderately stiff brush, from right to left and up and down, making a smooth, even, and very thin surface. Allow this to dry, after which it is flowed with a solution of albumen, made with the white of 1 egg and 16 ounces of water, dried by heat or allowed to dry spontaneously. Now coat it with another albumen solution made as follows: —

Formula No. 1. — White of 1 egg; water, 4 ounces; chloride of ammonia, 40 grains. Beat the whole to a thick froth. Allow it to subside, then decant or filter through a fine sponge placed in a glass funnel. Pour a sufficient quantity on one corner of the block to cover it, when spread around with the aid of a one-ninth or one-sixth glass (using the edge). Allow the surplus solution to drain back into the bottle. Dry by a gentle heat.

Formula No. 2. — Ether, 1 ounce; alcohol, 1 ounce; gun-cotton, 8 grains; nitrate of silver, 30 grains; dissolved in as small a quantity of water as possible, and allowed to settle for a few days, protected from the light. Flow the salted block with formula No. 2, in the dark room, and dry it by a gentle heat. It is now ready for exposure under the negative. A porcelain printing-frame, or any other suitable method, may be used to print it. After printing, formula No. 2 is removed from the surface of the block by dissolving it in ether and alcohol, assisted by rubbing gently with a soft sponge. The picture can now be toned and fixed in the ordinary way, or fixed and toned at one operation, by the hypo and gold bath. After being allowed to dry, it is ready for the engraver.

THE OXYGEN LIGHT.

According to the "Opinion Nationale," Paris, the new *Prefet de la Seine* has definitively authorized the Tessie du Motay Company to lay their underground communications in the city of Paris for illuminating with oxygen gas.

A system of pipes will connect the oxygen works of Pantin with the boulevards, and in a few months all the inhabitants residing between the "New Opera" and the Passage Jouffroy will thus be enabled to benefit from the immense advantages offered by this new light over the old gas.

Already oxyhydric lanterns have been placed at the entrance of the bazaar European, near the Passage Jouffroy, and project a light of the purest white and the most dazzling brilliancy, near which the old gas pales and appears to shine with the most singular yellow color.

The journal referred to congratulates M. le Prefet de la Seine for having ratified a measure in accordance with the general wishes and interests of the people, and which appears to it to be the indispensable corollary of the great improvements undertaken within a few years in Paris.

USE OF CALCIUM LIGHTS AT THE ST. LOUIS BRIDGE.

Mr. W. Milnor Roberts, who is in charge of the work, says. "We have used calcium lights only for our open-air work in laying masonry on the top of our caissons, — one light on one side, and one at the other, on diagonal corners; we found that they distributed the best light when thus placed. We had the oxygen gas forced into copper gas-holders with a pressure of about 200 pounds to the square inch. These were carried over from the city to the piers on a little steamer, and the gas was conveyed to the burner through small lead pipe. At first our reflectors were of glass, but so many were broken that they were replaced by metal. A man remained with the two burners through the night, to regulate them occasionally, and to mend the pipes when a burst occurred. They usually burn from 11 to 12 hours; and, with the aid of some movable large reflector lamps, the masons worked as well at night as in the day. The cost of the calcium lights to our company was 3¾ dollars per hour each."

MACHINES FOR PREPARING RHEA GRASS.

A short time since there appeared in our columns an advertisement from the Government of India offering a reward of £5,000 for the production of the best machine for the extraction of fibres from the Rhea grass and preparing it for market. The conditions upon which this prize was offered will doubtless be remembered by all interested in the subject, and we need not, therefore, refer to them again on the present occasion. The great drawback which has hitherto prevented the utilization of this grass has undoubtedly been the difficulty of extracting the fibre, the manual process being so expensive as almost to amount to a prohibition of fibre manufacture being carried on. "Engineering" states that during the last 20 years or so, a number of machines have been brought out for extracting fibre, but none of these have been considered entirely satisfactory. Up to the present time the common mode of extracting the fibre from such plants as the aloe is by soaking the leaves in water till the vascular matter has become rotten, and then beating off this decayed matter from the fibre with a wooden mallet, or scraping it off with a blunt knife. This process is not only a slow and nasty one, but is attended with much waste of fibre; it also discolors, and, what is most important of all, weakens the fibre. At the London Exhibition of 1862, two American gentlemen named Sanford and Mallory exhibited a machine for extracting fibre from aloe, plantain, or pine-apple leaves. This machine has been used in America, but would scarcely be found either sufficiently simple or cheap for the ryots of India, its cost being about £45. What is wanted is a cheap machine of simple construction, by which the fibre can be easily extracted; and we think it only due to those of our readers who have contemplated entering the competitive list for the above-mentioned prize to state that a machine, possessing, so far as our present information goes, all the necessary requirements, has already been invented in India by Mr. Donald Cruikshank, representative of the Telegraph Construction and Maintenance Company. No preparation of the leaves is required for this machine; they are taken to it green, just as they are cut from the bushes, and in the wonderfully short space of 2 minutes the fibre in the leaves is brought out stripped of vascular matter, and in admirable condition. The rotting process not being necessary with this machine, the deteriorations in color as well as in the strength and fineness of the fibre, which follow upon the adoption of that process, are avoided. A correspondent of an Indian contemporary asserts that the samples from Mr. Cruikshank's machine were "fine, delicate, and even; not one was cut or broken; and the material would readily fetch £50 a ton in the home market." Assuming that the efficiency and simplicity of *the machine is equal to* anything that is likely to be set up in competition with it for the offered prize, we very much doubt whether it is likely to be surpassed in point of cheapness. It is so easily worked, we are informed, that any native may be taught to use it in an hour's time, and its construction is so simple that it can be sold at 10 rupees (£1 sterling). — *Scientific Annual.*

NICKEL PLATING.

The specimens of nickel plating are exceedingly interesting. It is only recently that attention has been called to this new industry, but the success that has attended its introduction is most gratifying. If, as is claimed by the company, nickel can be deposited so much cheaper than silver, we see no reason why it should not be generally adopted. As it does not oxidize or rust, or become tarnished by fumes of sulphur, and is hard and will wear for a long time, it will find favor even if the cost were the same as that of silver. The company claim that "the cost of nickel plating is from 20 to 30 per cent. cheaper than silver, presents a more stable and uniform brilliancy, and lasts 4 times as long as silver plating of like thickness. We should suppose that nickelizing would be advantageously employed as a substitute for galvanizing for metals used on board ships; it can also be used to advantage on guns, harness, carriage-trimmings, surgical and philosophical instruments, reflectors, knives, forks, machinery of all kinds, and all models that require to be protected from the oxidizing or corroding action of the air or water. As nickel is a magnetic metal it cannot be used about the ship's compass; but on the state-room doors and ornamental hinges and knobs it can have no bad effect.

The following is the substance of the patent granted to Dr. Isaac Adams, March 22, 1870. The process is said to be very successful: —

This improvement consists in the use of 3 new solutions from which to deposit nickel, by the electric current: First, a solution formed of the double sulphate of nickel and alumina, or the sulphate of nickel dissolved in a solution of soda, potash, or ammonia-alum, the 3 different varieties of commercial alum; second, a solution formed of the double sulphate of nickel and potash; third, a solution formed of the double sulphate of nickel and magnesia, with or without an excess of ammonia.

I have found that a good coating of nickel can be deposited by the battery process from the solutions hereinbefore mentioned, provided they are prepared and used in such a manner as to be free from any acid or alkaline reaction.

When these solutions are used, great care must be taken, lest by the use of too high battery power, or from the introduction of some foreign matters, the solution becomes acid or alkaline. I prefer to use these solutions at a temperature about 100° Fah., but do not limit my invention to the use of these solutions at that temperature. I therefore claim — 1. The electro-deposition of nickel by *means of a solution* of the double sulphate of nickel and alumina, prepared and used in such a manner as to be free from the presence of ammonia, potash, soda, lime, or nitric acid, or from any acid or alkaline reaction. 2. The electro-deposition of nickel by means of a solution of the double sulphate of nickel and potash, prepared and used in such a manner as to be free from the presence of ammonia, soda, alumina, lime, or nitric acid, or from any acid or alkaline reaction. 3. The electro-deposition of nickel by means of a solution of the double sulphate of nickel and magnesia, prepared and used in such a manner as to be free from the presence of potash, soda, alumina, lime, or nitric acid, or from any acid or alkaline reaction.

USE OF BORAX IN GLASS MANUFACTURE.

MM. Maës & Clemendot, glass manufacturers at Clichy, produce a crystal as fine as the best Baccarat and St. Louis crystal by using boracic acid.

The presence of this flux allows a modification in the composition of the crystal, as the oxide of zinc can then be substituted for the oxide of lead; and soda, lime, or barytes can thus replace potassa.

The barosilicates of zinc and potassa, of potassa and barytes, of soda and zinc, manufactured by Maës & Clemendot, are remarkable for their limpidity and whiteness. The following are the proportions: —

Silicious sand (white),	261	225
Minium,	261	225
Potassa (1st quality),	60	52
Borax,	18	4
Nitre,	18	3
Manganese,	18	1
Arsenious acid,	18	1
Refuse of former operations,	18	89

GLYCERINE CEMENT.

Professor Hirzel, of Leipzig, has discovered an important use of glycerine that ought to be more generally known. He finds that when glycerine is mixed with fine and well-dried litharge, it yields a cement that is capable of a large number of applications.

All metals and nearly all solid bodies can be bound together by this cement; it is said to harden under water as readily as in the air, and to resist a temperature of 500°. It is especially recommended for such pieces of apparatus as are exposed to the action of chlorine, — hydrochloric acid, sulphuric acid, sulphurous acid, and nitric acid; also the vapor of alcohol, ether, and bisulphide of carbon, — as none of these agents act upon it. The cement can be used in steam engines, pumps, foundations for machinery, and, finally, as a substitute for plaster in galvano-plastic and electro-plating. The proportion of glycerine and litharge to be taken must depend somewhat upon the consistency of the cement, and its proposed uses. An excess of glycerine would retard the setting, as it does not readily evaporate. This new use of glycerine adds another application to a substance that only a few years ago was thrown away.

CHINESE GOLD-LACKER.

The gold-lacker lining of a Chinese cabinet in the Museum at Cassel peeled off, and thus gave Dr. Wiederhold the opportunity of studying the composition of this substance. On examining it he found particles of tin foil attached to the lacker; so he comes to the conclusion that this material formed the ground upon which the lacker varnish was laid. His attempts to imitate the varnish were perfectly successful, and he gives the following directions for the preparation of a composition which closely resembles the true Chinese article. First of all, 2 parts of copal and 1 of shellac are to be melted together to form a perfectly fluid mixture, then 2 parts of good boiled oil, made hot, are to be added; the vessel is then to be removed from the fire, and 10 parts of oil of turpentine are to be gradually added. To give color, the addition is made of solution in turpentine of gum gutta for yellow, and dragon's blood for red. These are to be mixed in sufficient quantity to give the shade desired.

MALLEABLE PROPERTIES OF CHINESE BRONZE.

The "Journal of Applied Chemistry" thinks the unsuccessful attempts made to manufacture Chinese gongs and bells, in Europe and the United States, are due to the mistake that was made of hammering the Chinese alloy at the ordinary temperature, instead of working it at a high temperature, according to the recent discovery made by Professor Riche, of Sorbonne, who has been perfectly successful in his experiments made on a large scale at the Paris Mint.

The different analyses have shown that the Chinese alloy was formed of a certain proportion of tin and copper, in the proportion of 20 parts of tin to 80 of copper. Ingots of bronze were cast containing 21.5, 20.0, 18.5 per 100 of tin; these were afterward submitted to the action of the hammer, at temperatures varying from the ordinary temperature to a red heat. At the ordinary temperature the metal was as brittle as glass, but approaching 300° to 350° Centigrade a sensible amelioration was noticed. At a dark-red heat it appears that the condition of the metal is quite different, as this alloy can be worked as easily as iron or bronze of aluminium.

The metal flattened without cracking under the most powerful blows of enormous hammers, and can be reduced without the slightest difficulty to sheets of one millimetre thickness. These sheets have exactly the appearance of the Chinese bronze, and possess great flexibility.

The action of the laminating is more striking, because, under the hammer, the metal is so soon cooled; that is, it has to be reheated from time to time, which operation complicates the work; in using a laminating machine the work is done with extreme rapidity, especially if care is taken to heat the alloy to a red heat. At an ordinary temperature a single passage under the laminators would break the sheet in thousands of pieces. This alloy can be cut at a high temperature like iron and steel, and presents the fine and homogeneous grain of the latter; it is soldered without difficulty with the ordinary jewellers' solder.

The following tests will demonstrate that the density of the bronze suffers very little modification by the hammering or laminating process: —

Chinese Bronze.	Density after Smelting.	Density after Hammering.
Bronze at 21.5 per cent. tin,	8.938	8.929
Bronze at 18.5 per cent. tin,	8.882	8.938
Bronze at 20.0 per cent. tin,	8.924	8.920
Bronze at 20.0 per cent. tin,	8.918	
Bronze at 20.0 per cent. tin,	8.912	

ZINC AS A BUILDING MATERIAL.

Stone, and stone only, says the "American Builder," has always been deemed, by architects and others, the appropriate material to be employed in the ornamentation of buildings, and doubtless there has existed, until a comparatively recent date, the best of reasons for this theory. First, stone is durable; there is nothing ordinarily entering into the composition of our buildings that, in this respect, can compare with it; and again, from its peculiar facilities, few other suitable substances can be worked into the required form, offering the means for such boldness and strength in the general effect, or such correctness and delicacy of detail. On the other hand, however, stone can be employed only at a considerable expense, both in working and transportation, and, in some localities, distant from quarries, this expense reaches a point where the employment of such material is practically precluded, save where its use is an absolute necessity. In ornamented fronts especially, where stone has heretofore been considered indispensable, its use is being discarded, and metal imitations are taking its place.

The principal objections raised against the use of metal lie in the fact that it is untruthful, and, therefore, inappropriate; but certainly the use of an imitation in this particular is in no sense more appropriate than the use of hollow iron columns in imitation of stone, and the employment of similar counterfeits in interior ornamentation. Prominent among the substitutes for stone is zinc, a material which has proved eminently adapted to the purpose, and is rapidly acquiring a place among the building material from its adaptability to all forms as well as from its lasting qualities. With the introduction of pressed ornaments of this material the expense of exterior decorations has been greatly reduced, and an additional advantage is gained in the fact that, from the facility with which it is worked, there exists but little difference in the cost of the plainest and most elaborate patterns. The work, when coated with paint suited to the purpose, may be made to resemble cut stone work so closely as to deceive the eye of any one not an expert; and in like manner the interior of buildings can be ornamented with zinc in imitation of stucco, or embellished with elaborate mouldings at a small cost, which work may be cleaned at any time without fear of injury. In the ornamentation of old buildings, which, if of cut stone, could only be accomplished by taking down the walls, zinc also plays a useful part, as decorations may be put on without displacing any portion of the structure. As a roofing material its value has become generally acknowledged in Europe, and, in this country, is rapidly acquiring an equally high reputation, particularly in the construction of large buildings. When exposed to the influence of the atmosphere, the oxidation that at once ensues, instead of rapidly eating up the metal, soon forms a crust which hardens and effectually protects the body of the covering from further damage.

The points which we have presented above in regard to ornamentation are simply those which seem most important in demonstrating the value of zinc as a building material, and while we do not by any means advocate its use generally in the place of stone in ornamentation, where stone is plenty and cheap, yet we wish, if possible, to overcome the prejudice which appears to exist in many instances where the employment of zinc would be more economical and equally appropriate.

PROGRESS OF INVENTION ABROAD.

In a paper read before the British Association for the Advancement of Science, Mr. J. W. Cooper, who has given much attention to the *Watering of Streets by Chemicals*, states that 3 streets in the city of Liverpool were watered with salts during the month of July, 1869, with very favorable results, so much so that the experiments were continued this year. It was difficult to prove the economy resulting from the use of chloride over a limited area; and the Westminster Board of Works, after observing the effect produced at Whitehall and Knightsbridge, resolved to extend the experiment throughout their entire district, comprising an area of 250,000 square yards. As soon as the area was extended, the economy in labor and water was at once made evident. By using 1½ ton of chlorides per day, costing £3 15s., the labor of 10 cart-horses and men, costing £4 10s. (at 9s. per horse, cart, and man), can be dispensed with, and, consequently, the quantity of water they would spread is saved also, namely, 350 loads of 250 gallons each, which, at 10d. per 1,000 gallons (a fair average price for water in London), would amount to £3 12s. 11d. in addition to the 15s. per day saved in labor; thus showing a *clear gain of* £4 7s. 11d., after paying for the salts.

An effective method of remedying the evils arising from organic matter deposited on public thoroughfares is becoming daily a serious matter for consideration with sanitary authorities, as much sickness is believed to arise from the malaria emanating from this source. The disgusting odor and dangerous nature of some of the deodorizing agents used were strong evidence that they would not be used at all if the necessity for some determined action to prevent the spread of contagion and disease was not fully recognized. The deliquescent chloride of aluminum, recently introduced to public notice by Professor Gamgee, seemed to meet all the requirements needed in the antiseptic of the future. It was non-poisonous, and free from any odor; it prevented decomposition, and arrested it when commenced. It absorbed noxious gases resulting from putrefaction, and destroyed parasites and germs. It was also not to be surpassed as a precipitant and deodorizer of sewage, and was only one-third the cost of carbolic acid. Mr. Cooper proposed to add a sufficient percentage of this chloride to the salts for street-watering, and thereby afford a means of thoroughly and effectually purifying public thoroughfares without additional cost to the rate-payers, the value of the water and labor saved being more than sufficient to pay for the use of the chlorides.

There seems to be considerable activity in invention abroad. The stimulating effect of the war on military invention seems, however, to be gradually subsiding.

Interesting to nautical men is a newly patented *Steering Gear*, which is an ingenious application of hydraulic pressure to move the rudder. The rudder-head is provided with a strong tiller, which is actuated by means of a pair of hydraulic rams placed horizontally on each side of the tiller athwart the ship. These rams are connected together at their inner ends, between which they carry a block or bush, which works on the turned cylindrical end of the tiller, and which permits the tiller to slide radially. These hydraulic cylinders have branches attached to their outer ends, to which strong hydraulic pipes terminate in a slide valve chest having three ports, namely, one of the end ports, communicating with one of the above-named hydraulic cylinders, which the inventor calls the port cylinder, the other extreme part with the other or starboard cylinder, and between these two ports the exhaust port is laid.

Mr. E. Weare, of Stonehouse, England, has patented a method of *Utilizing Waste Thread* in the manufacture of textile fabrics. He accomplishes the end sought by returning the waste threads to the condensing carding engines by means of mechanism, the greater part of which is attached to one of the scribblers, in preference to the last. Over the end of the carding engine, rollers are fixed, over which rollers the waste thread from one side of the engine is conducted to the other side, and the threads from the two sides of the engine thus brought side by side. The waste threads are taken up by, or coiled upon, a roller or spoon driven by any convenient gearing from the carding engine or otherwise; and the said roller or spool, when filled with the waste threads, is conveyed to the scribbler (the axis of the roller or spool placed in suitable supports), and made to bear or rest on a second roller or drum, which has a slow, uniform rotary motion communicated to it, whereby the waste threads are uniformly delivered into the sliver as it comes off the scribbler. The sliver passes to the condensing carding engine in the usual way.

Pentagraphic Embroidery is a name applied to an ingenious method of performing needle-work, invented by Mr. Billwiller, of St. Gall, England. A number of jointed frames are employed, each carrying tambouring or sewing apparatus. They are so arranged and connected together that the needles they carry may be made to traverse in any direction over the surfaces of the fabrics to be embroidered, and that the movements of the several needles shall be simultaneous and similar. The needle-frames are also connected with a pentagraph having a tracing point capable of being led by the workman over the lines of a pattern which it is desired to copy, and when this is done the needles will each travel in and work along a path similar to that passed over by the tracing point. Thus each needle will produce embroidery resembling the pattern, but not necessarily of the same size; usually it is preferred that the pattern should be on a larger scale than the work produced by its means.

Paving Streets—French—consists, first, in the employment of wood disintegrated into fragments, of as great a length as possible, in the construction of rides and bridle-paths, carriage-drives, riding-schools, and training-grounds, streets and roads of all kinds. Second, in the employment of disintegrated wood of shorter length than the preceding, in the construction of footpaths of all kinds for promenades and gardens. Third, in the employment of disintegrated wood, mixed or not with pitch or with antiseptic material, or both, as a cushion for supporting the sleepers of railways. Fourth, in the employment of this disintegrated wood, mixed with pitch obtained from gas tar or otherwise, or with natural asphalte or bitumen in the construction of roads, footways of streets, public drives, and any description of works in which asphalte is ordinarily employed.

Sir William Fairbairn, of Manchester, England, has invented an improvement in *Steam Boilers* in which he combines together 3 cylindrical shells of boiler plate. He arranges them parallel the one to the other, and horizontally, or nearly so. Two of the cylinders, which are set side by side, are each traversed from end to end by an internal tube, in which are the furnaces, and these cylinders each communicate with the third cylinder, which is placed over and between them, by 3 or other number of pipes or passages, of sufficient size to allow the steam generated in the lower cylinders to escape freely into the upper, and to allow the water freely to circulate.

A Liverpool inventor has patented a taper or *Friction Light*, which is made after the following formula: He takes 1 ounce saltpetre, one-half ounce powdered orris-root, one-eighth ounce of minium, and 1 ounce of phosphorus, or any other convenient friction-match composition. To these ingredients, the phosphorus being dissolved, he adds 1 to 2 ounces of oil, preferably castor, oil, varying the quantity according to the nature of the oil and the resultant tenacity or flexibility required. After all the ingredients are well incorporated, the inventor adds thereto chloride of sulphur, in the proportion of from 10 to 15 parts of liquid chloride of sulphur to every hundred parts of oil, agitates quickly, and shapes into the form required, either by moulding, cutting, pressing, or drawing.

A very ingenious automatic device for *Flushing Sewers* has been produced by a London inventor. In this device, the flood-gate is hinged, opening upward and outward upon the release of a hook bolt by the buoyant power of a large copper float. Many lives have been lost through the action of poisonous gases, in flushing sewers, which flushing this simple device does whenever it is required. The rush of accumulated water swings the gate outward, and also carries off accumulations of sewage. As soon as the flood current subsides, the gate swings back to its original position, and is automatically locked.

A machine for *Hackling Long Vegetable Fibres*, such as aloe, manilla, hemp, etc., consists of a drum, revolving on a horizontal axis, and armed with teeth or spikes pointed at the end, and having sharp, annular edges in front, or at the front and back. This drum is of such a size that the fibre upon the machine shall not be able to lap more than about half way round it. This is an English invention.

A French invention, in the same line as the above, is a machine for *Combing Flax*. Two endless chains, consisting of flat links, are caused to travel together over flat-sided pulleys, and disposed one above the other; the two adjoining or opposing surfaces of the two chains being held in contact with each other by passing between guides. These surfaces form nippers for holding the tufts of fibres while being combed or straightened, and serve to carry them along, at the same time, to a receiving-trough, wherein each tuft is deposited in succession, the one overlapping slightly the other. The bottom of the receiving-trough consists of an endless travelling band, which continuously conveys away the combed tufts in the form of a ribbon or sliver. A vibrating arm, worked by a crank and provided with a cross-head or rake, serves to take each tuft as it is released from the nippers, and draw it into the receiving-trough.

A Swedish inventor has patented a process for making *Artificial Leather*. He takes leather wastes, leather cuttings, leather shavings, or other small bits of leather, either new or old, and reduces them to a kind of fibrous pulp, by hand labor, or by a machine or mill (either by grinding, pounding, cutting, rasping, carding, or grating) ; if old waste is used it should first be cleaned thoroughly. This matter or pulp is then kneaded with India-rubber, which is rendered fluid, or dissolved in oils or spirits, and treated with ammonia. He prefers to dissolve the India-rubber in oil of turpentine. To effect this, the inventor cuts the India-rubber into pieces and mixes it with the oil, after which he lets it remain quiet in a closed vessel until it is dissolved. When the

India-rubber is dissolved, he adds ammonia, of a strength of 30 per cent., in the proportion of about equal parts by weight of ammonia to the India-rubber contained in the solution; when the mass has become of a grayish-white color it is ready to be mixed with the pulp.

A protective coating for iron and other metals has been invented by Mr. J. Crouziers, of Ollioules, France, to which the inventor has given the name of *Electro-Cathodic Insulating Mastic*, which to the scientific reader will convey the fact that its application will prevent the corrosion of metal when immersed in fluids calculated to generate galvanic action. Its composition and application are as follows: Take of sulphur (say) 38 per cent.; coal tar, 20 per cent.; gutta-percha, 5 per cent.; minium, or red lead, 6 per cent.; white lead, 7 per cent.; pitch, 10 per cent.; resin, 10 per cent.; spirit of turpentine, 4 per cent.; total, 100. Melt the sulphur in one vessel, and coal tar, gutta-percha, minium, white lead, pitch, and resin, all together, in another; but before adding the gutta-percha to the coal tar, dissolve it, as far as possible, in the spirit of turpentine, and when all these ingredients have melted, pour in the sulphur very gently from the separate vessel, then thoroughly mix the whole, and apply the composition hot by the aid of a brush, by dipping the article to be coated into it, or in any convenient manner.

Mr. Crockford, of Dublin, Ireland, has invented several new processes for utilization of waste products. One of these is a method of treating what is known as flux skimmings, produced in the process of galvanizing or coating iron with zinc. For this purpose he adds a sufficient quantity of hydrochloric or sulphuric acid to the flux skimmings to dissolve all the zinc, and then precipitates all the zinc with the ammoniacal gas arising from the distillation of gas liquor, by which means he obtains oxide and sulphide of zinc and hydrochlorate or sulphate of ammonia. Sometimes he passes through the solution, toward the end of the operation, a stream of sulphuretted hydrogen, for the purpose of rendering the precipitation quite complete.

A second process by the same inventor consists in the treatment of the liquor from paper mills resulting from boiling esparto grass, wood, or other materials in caustic soda. He first evaporates the liquor to dryness, and then submits the dry product to distillation at a red heat, whereby the volatile and other matters are collected, and he afterwards extracts the carbonate of soda left in the furnace or retort in which the distillation has been effected by lixiviation, at the same time extracting a quantity of black, similar to "lamp-black."

The same inventor has devised a method of condensing and collecting the fumes and gases from the flues of furnaces in which lead and other ores are smelted. To do this he draws off the mixed fumes and gases from the flues of furnaces wherein lead or other metal is smelted, and forces them, by means of a fan or other similar means, into and through a quantity of filtering material, such as canvas, cotton, or fine coke, which material may be renewed from time to time when it becomes clogged: before passing the fumes and gases through the said material they are cooled by passing them through showers of water or otherwise. Thus materials which would otherwise be destroyed by the heat are utilized.

A Hungarian gentleman has, we are told, constructed a railway 5 miles in length on a mountain in the heart of Hungary. A remarkable peculiarity is the total absence of all permanent way. Square beams of oak 8 in. high and 14 in. broad are laid on the ground, and only at rare intervals, where the great unevenness of the ground absolutely requires it, cross-sleepers are laid under them. Each of these longitudinal beams has a length of 18 ft., and on the two edges of the beams are the rails, which are only 2 in. broad, and so thin that they weigh about 1 lb. per foot. These beams and rails may be taken up at any moment, and the railway thus relaid whenever it is required. The trucks run on two pairs of wheels 8 in. in diameter; the bodies of the trucks are about 3 times the width of the rails, and are placed so low on the wheels that they have just room to pass over them. The arrangement of the weight and the system of brakes are said to be so perfect that the train may be stopped when on a gradient of 1 in 7, and going at the rate of 20 or 30 miles an hour, within 6 to 8 yards. The 5 miles cost 10,000 dollars, and after the experience now gained the work may be done for about 1,000 dollars per mile.

The substitution of heavy paraffine oils for high-pressure steam, used to obtain high temperatures for the evaporation of liquids, has been made in an establishment at Lambeth, England. These oils may be heated safely to a temperature of from 600° to 700° Fah., and they circulate in heating exactly like water. In the establishment alluded to the apparatus used is as follows: A close system being made, the oil heated in a coil pipe placed in a furnace rises first to an air-tight tank, from which it runs through pipes and the jackets of pans, descending as it cools to the coil of pipe in the furnace. It is claimed that the method, besides being safer, is more economical than steam. A pyrometer is contrived to show the exact temperature of the oil as it leaves the tank, and means are provided for regulating and keeping the temperature uniform. This method appears to us to possess great promise, and, if it prove entirely successful, is capable of extension to many important branches of industry.

M. Ducomet, of Paris, has invented a simple and ingenious method of cutting glass tubes. It consists in the employment of a metallic rod with a diamond set in one end, the rod being covered with plaited cotton and supplied with a movable gauge to regulate the length. To use this instrument, all that is necessary is to introduce the end carrying the diamond into the tube to be cut, and then turn it around so as to make a scratch with the diamond around the interior of the tube at the point where it is desired to separate the latter. The correct position of the cut can be insured by the use of the guard, which can be fixed at any desired point on the rod by a screw. After the cut or scratch has been made in the manner described, the tube can be at once divided at the desired point by merely bending it, or, if the piece to be cut off is very short, all that is necessary is to hold the tube above the flame of a lamp or candle, when it will at once divide at the point where the diamond cut was made. M. Ducomet states that it is absolutely necessary that the rod should be covered with cotton or similar soft material, or that otherwise tubes cut in this way — gauge-tubes for instance — will subsequently break when in use. The instrument is particularly adapted to cutting gauge-tubes.

SINGLE RAIL TRAMWAY.

Mr. J. W. Addis, C.E., is experimenting in India on a new form of single rail tramway. The vehicles used, in addition to the ordinary wheels, have a pair of flanged wheels, one behind the other, running on the single rail, which is laid at the centre of the track. The flanged wheels are adjusted by a screw so as to take all the weight off the ordinary wheels, without lifting them much above the roadway. An experimental line has been laid, in part at an incline of 1 in 40, and along this a pair of bullocks draw a load of 3 tons. The advantages claimed for the system are: first, a very great diminution of power expended in hauling as compared with traction on common roads; secondly, that the cost of construction is only one-half that of an ordinary tramway with 2 lines of rails. A tramway or railway on a similar principle was, we believe, tried some time ago in France. — *Science Review, Oct.*, 1870.

VENTILATION OF COAL MINES.

Mechanical ventilation in coal mines is steadily gaining ground on the older plan of producing a draught in the up-cast shaft by means of a furnace. Mr. D. P. Morrison recently read a paper on the subject before the North England Institute of Mining Engineers, at which he stated, that in the deepest English coal mines, mechanical ventilation would show an economy of 35 to 40 per cent. over furnace ventilation. After discussing various arrangements of mechanical ventilators, he gave the preference to the Guibal centrifugal fan. — *Science Review, Oct.*, 1870.

PETROLEUM FOR HEATING LOCOMOTIVE BOILERS.

Two engines on the Strasbourg line have been fitted with M. Deville's furnaces, and are employed in the goods traffic. The consumption of oil in the engines drawing heavy trains is stated to have been from 3½ to 5 kilogrammes for every kilometre traversed, or from 8 pounds to 12 pounds for every two-thirds of a mile. The oil is said to be very completely burned, and there is no smoke and consequently no waste. Another advantage claimed is, there being no sulphur in the oils the atmosphere of the tunnels would be free from that most disagreeable and obnoxious contamination, sulphurous acid. — *Journal Franklin Institute.*

SLAG.

Mr. Joseph Woodward has taken out a patent, which may turn out to be of great importance to every iron-smelting district in England. The millions of tons of slag running from the blast furnaces, and piled up in such unsightly heaps in all such districts, are to be utilized in the manufacture of a new brick. It is stated that the brick is damp-proof, that it is very solid and firm, without flaw, and pleasing to the eye. The inventor opines that it is likely at once to take the place for ornamentation at present occupied by the costly Staffordshire blue brick. Mr. Woodward's brick can, it seems, be produced so economically, that they can be offered at less per thousand than the ordinary clay and fire-bricks. — *Van Nostrand's Eng. Mag.*

AN EARTHQUAKE-PROOF CHURCH.

The people of California, since the earthquakes of 1869, have a great fear of recurring shocks, and, as an indication of this wholesome alarm and a desire to prevent loss of life, we have intelligence from San Francisco that the Roman Catholics are building there an "earthquake-proof church." This edifice — St. Patrick's Church — is built on a plan to prevent loss of life in the event of the shaking down of the walls. The side walls above the basement are only 30 feet high. At this height a roof rises, which, with the main roof, is supported independently of the walls by 2 rows of pillars inside of them. Both roofs are firmly bound to the pillars, and the pillars are fastened together by iron cross-beams, secured with heavy iron bolts, forming a network of great strength. The theory of the plan of construction is, that, should the pillars be shaken down, the roof would be launched off outside the walls, instead of falling inside, thus giving a chance of escape from the ruins. In thus falling, the roof would be carried aside a distance of 80 feet, the length of the pillars. — *Scientific Journal.*

MONT CENIS TUNNEL.

The state of the works on Mont Cenis Tunnel, Jan. 1, was as follows: From the south, 20,510 feet had been executed, and from the north, 14,953½, making a total of 35,463½ feet, and leaving 4,914 feet to be accomplished. — *Van Nostrand's Eng. Mag.*

[Jan. 1, 1871. — News has been received of its completion.— *Editor.*]

NEW LIGHTHOUSE APPARATUS.

In the Lochindaal Lighthouse, in the island of Islay, Argyleshire, dioptric prisms of a new form have been introduced. The light which passes behind the flame has hitherto been sent forward by two optical agents, so as to mingle with the front light, and thus to reach the eye of the mariner; but the object is now effected for part of the upper core of rays by means of the new prisms alone, so that one agent is saved, and the loss of light by absorption and superficial reflection is prevented.

The prisms act by refraction and total reflection, and consist of glass of the ordinary index of refraction. By means of the prisms and a spherical mirror, the whole of the back light is sent forward.

THE WORKING OF BRONZE.

The secret of the manufacture of Chinese gongs seems to have been revealed recently by MM. Julien and Champion, who have found that bronze, which is brittle at the ordinary temperature, becomes malleable at a dull red heat. Experiments lately made on this matter at the Paris mint, with the view of determining the conditions most favorable to working the alloy, found that a bronze containing 20 per cent. of tin, which at the common temperature is as brittle as glass, may, at a dull red heat, be forged and beaten out as easily as soft tin.

IRON SHIPS.

Iron for ships is rapidly superseding wood in English shipyards. In 1865 there were 806 wooden ships built in England, in 1869 but 324. In 1868 the tonnage of iron ships built was 235,937, against 66,977 wooden, and 24,121 of composite. Iron ships are more durable, require less repairs, and stand heavier storms than those of wood, and it will not be long till the latter must be entirely superseded.

GUNNERY EXPERIMENTS.

The London "Globe" details some late artillery experiments which showed that, in spite of all possible care in the arrangement, the exact level of the centre being taken on the target by means of a theodolite, the shot would strike 10 inches above it. Theoretically, the shot would fall by gravity, and its centre should have struck about 2 inches below the level. The probable explanation is, that the recoil is sensibly felt before the shot has left the gun, and that the resultant of the forces acting on the gun and carriage tends to throw the muzzle up; thus the projectile, although seemingly fired point blank, really leaves the gun at an angle. With the 12-pounder breech-loading gun this angle was found to equal about 30 minutes, while with the 9-pounder muzzle-loading Indian gun it equals about 13 minutes. The difference is probably due to the projectile taking a longer time to pass through the core of the breech-loading gun. It may be mentioned that when the gun is swung as a pendulum and fired with its axis horizontal, the shot strikes below the level.

CUTTING UP LARGE IRON SHAFTS.

The Buffalo correspondent of the "New York Tribune" writes: "It is frequently very difficult to break up great shafts of cast iron when necessary to prepare them for the furnace. Old cannon have, therefore, sold low. Upon some, powder and nitro-glycerine have been tried in vain. Some have been burst by ice, others by wedges driven by machinery or long-continued hard labor into the muzzle. Here they are cut in two by a continuous stream of molten iron, which wears away the iron as a stream of hot water would eat into a mass of ice. The gun is rolled upon a frame in front of and level with the furnace mouth. Then the muzzle end is shoved in as far as possible among other iron, the opening filled up and luted around the gun, the end of which is melted off. At the next charge it is shoved in another length, and is thus reduced until the breech can finally be rolled in and thus finished without any more expense than with pig or scrap iron.

AN EIGHT-TON STEAM HAMMER.

The Landore Steel Works have erected a single-acting steam hammer, the head of which weighs 8 tons. The cylinder is 30 inches in diameter. The anvil block, which is cast in one solid piece, weighs 75 tons.

CORROSION OF IRON WATER PIPES.

Two wrought-iron pipes, 7 feet in diameter, have been laid on the aqueduct bridge by which the Croton water is carried over the Harlem River, and much trouble has been experienced from their rusting, but on examination it appears that at each joint, where a lap of some 15 inches is made, no notable amount of rust is formed on the entire belt under the lap. It was, at first, supposed that some molecular change, produced by the riveting (which is double), was the origin of this protection, but this idea is opposed by the fact that the rivets in other parts show no such action, and that the protection in the laps is not concentric with the rivets, but stop abruptly with the edge of the lap. Mr. Graff also informs us that the plan of painting the pipes, when hot, with boiled coal tar, has met with uniform success in his experience, and also at Boston, where very serious difficulty was before experienced by stoppage from accumulation of rust. An attempt to protect the Croton pipes by strips of zinc entirely failed.—*Journal Franklin Institute.*

HIGH-PRESSURE CONVERTER.

Mr. Bessemer has patented a method of conducting his process under pressure, by means of which sufficient heat is produced to retain complete fluidity in the steel until it is poured into moulds. For this purpose he makes the converting vessel of great strength and as air-tight as possible, and makes the mouth of it circular instead of oval, and of smaller size than usual, lining this mouth with a ring of well-burnt fire-clay or a composition of clay and plumbago. Mr. Bessemer states that for the conversion of the purer kinds of Swedish charcoal pig iron and for mottled or white hematite pig iron mixed with gray, a back pressure in the vessel of from 8 to 15 pounds on the square inch will give good results, and in but a few cases will a pressure of 20 pounds per square inch be necessary; while a pressure as low as 3 or 4 pounds will be of little practical advantage, and below 2 pounds per square inch he lays no claim to a useful effect.

MAGIC-LANTERN PICTURES ON GELATINE BY A NEW METHOD.

At the last meeting of the Franklin Institute, the Resident Secretary, Prof. Morton, exhibited in the lantern some pictures on gelatine, prepared in a manner devised by Mr. Shepherd Holman, a member of the Institute.

For this purpose, a sheet of gelatine, such as is used for tracing by engravers, was securely fixed over an engraving, and with a sharp steel point (made by grinding down the end of a small, round file), the lines of the original traced pretty deeply on the transparent substance. Lead-pencil or crayon dust was then lightly rubbed in with the finger, and the picture was at once ready for use.

A number of such drawings could be easily carried between the leaves of a book, could each in succession be placed in a frame or cell made of two plates of glass supported by a frame of thin card of three edges, and united by paper or muslin pasted around the same edges. The effect of these drawings in the lantern was excellent, and their ease of production very great.

PAPER FROM OAT-HUSKS.

W. Hay, of Glasgow, Scotland, has just patented the following process. He first immerses the oat-husks in water, in a tank or other convenient vessel, in order to float off mustard and other seeds with which they are generally more or less mixed, and which, if not separated, materially deteriorate the quality of the paper. It is of advantage to have the water well stirred, as it facilitates the separation of the foreign seeds, and allows them to float to the surface. The oat-husks are then allowed to settle, and the surface scum and floating seeds are drawn off by an overflow pipe at the top of the tank, or skimmed off by a rake or other tool, or otherwise removed, after which the water is drained from the oat-husks, by a waste-water pipe at the bottom of the tank, and beneath a perforated false bottom, fitted with a strainer which retains the oat-husks. The oat-husks may be left to steep in the water for from 5 to 10 hours after or during the removal of the scum, as this steeping, by softening them and helping to loosen the silica from the fibre, facilitates the subsequent boiling process. The remainder of the process does not differ materially from the ordinary one in making paper from straw.

AN IMPERISHABLE HOT-HOUSE.

From the recently published list of English patents it appears that Mr. W. P. Ayres has secured "Improvements in the Construction and Arrangement of Horticultural and other Buildings or Erections or Structures, and in the Means and Appliances for Heating the same." These consist of roofs formed without sashes, sash-bars, putty, or paint, or any wood-work outside, and consequently no painting will at any time be required. Secondly, Mr. Ayres forms his floors, plant-stages, and side or partition walls in slabs of cement concrete, strengthened in a peculiar manner so as to bear any amount of pressure that may be placed upon them, and yet admit of being perforated for the air to circulate through them, panelled to hold water for evaporation, or the pots to stand in, or perforated and panelled. These slabs, it is said, can be manufactured of any required strength, and, consequently, are suitable for fire-proof floors, partition walls, tabling, or shelving for shop, office, or warehouse fittings, or for any situations where slate or marble slabs have hitherto been used, with the advantage that they can be manufactured of any size, and in the place where they are required to be used, left rough for ordinary use, or be finished plain or in colors with the face of polished marble. Thirdly, Mr. Ayres introduces a new system of heating, dispensing with plunging or fermenting material for bottom heat, and substitutes a system by which a stream of air, moist or dry, is constantly passing through the centre of the earth containing the roots of the plant as well as around the sides of the pot. For glazing, Mr. Ayres uses flat glass of great strength and quality, jointed with transparent cement; or he may use glass turned up at the sides, or any other form of bent glass that he may find necessary for the purposes of his invention. The alleged advantages are, economy in first construction, portability (when desired), and when manufactured in iron, galvanized, a house so imperishable as to wear for a lifetime without further cost.

NEW INVENTIONS.

Herring, Farrel & Sherman, at the fair of the American Institute held in New York, exhibited a new style of burglar-proof safe, made of Franklinite, or *spiegeleisen*, combined with welded steel and iron. It is cylindrical, and the top is raised to open the safe or lowered to close it by a very strong vertical screw in the centre of the cylinder. As the top is raised, the wood-work, containing drawers and pigeon-holes, also is raised, so as to become accessible. A combination lock fastens the top when closed, so that it is held in a very secure manner. This safe appears to be a very difficult thing for burglars to deal with, and we judge will not often be attempted by that ingenious fraternity. A desk-safe, also of new style, exhibited by the same firm, is worthy of notice.

An application of electricity to bank locks, exhibited by the Electro-Bank Lock Company, No. 9 Willoughby Street, Brooklyn, is a most ingenious affair. A combination lock is worked entirely by electro-magnetism, and is placed within the safe on the *back wall*, opposite the door. Its wheels are worked by electro-magnetism, the circuit being controlled entirely by circuit-breakers placed in an office desk or any other convenient place. No one can unlock the safe without knowing the combination, and no key-hole or any other aperture in the walls of the safe exists whereby powder can be inserted. Burglars could only enter a safe provided with this lock by actually penetrating the wall. The lock itself is absolutely exempt from all tampering.

Among minor steam-engineering devices we noticed the American Eagle Steam Gauge, exhibited by the American Eagle Steam Gauge Co., 190 Market Street, Newark, N. J., belonging to the type known as mercurial gauges. It consists of a cast-iron chamber fitted to receive a thin corrugated steel diaphragm or disk, properly tempered, and plated with nickel, to prevent corrosion. The pressure acts upon the under side of it, the mercury covering the top side of the same, from which extends an open vertical glass tube, supported and protected by a metal case, having a graduated scale of pressure. Any slight movement of the disc will fill the tube with the mercury to a greater or less degree, whereby the pressure is correctly indicated. There is a screw by which the starting-point of the mercury can be readily adjusted, so that, whatever the temperature of the surrounding atmosphere may be, the indication of the pressure will be correctly indicated.

A recording pressure-gauge is shown by Charles G. Willing, of 88 John Street, New York, which gave a continuous and exact record of the pressure, and the time at which the pressure was sustained, automatically. The principle of recording is the tracing on a rotating disk of a pencil point in the end of the index hand.

W. H. Place, 8 Attorney Street, New York, exhibited an improved governor and valve, of novel construction, and apparently of great effectiveness. Mr. Place, the inventor, was formerly Chief Engineer of the Central American Transit Company. His invention consists of a vertical cylinder or case, in which are placed and attached thereto a series of inclined or spiral-formed ribs, within which revolves (in water or other liquid) a propeller-wheel, revolving and leading in an opposite direction from said spiral ribs in said *cylinder*, making the shaft, by passing through a series of friction rolls attached to the throttle valve, check or increase the motion of the engine, the stem of the shaft of the propeller-wheel passing through friction-rolls without packing, causing instantaneous and sensitive motion to depress or elevate the throttle-valve. The governor is operated from the main shaft by means of a belt and pulleys.

A novelty in the display of minor tools is Jones' Patent Joint and Mitre Planer, a hand-tool whereby a perfect right-angled or mitre joint may be made, or a piece be planed square or to any required angle, with ease and accuracy, even by the inexpert. This is accomplished by an adjustable table, upon which the piece is laid, and brought up to the cutting-iron of the plane, at the angle desired. The plane proper runs on ways, and thus has a perfectly parallel motion. — *Scientific American.*

GREEN GLASS FOR THE DARK ROOM OF PHOTOGRAPHERS.

Mr. Gaffield, of Boston, has shown that while chemical rays to a slight degree will pass through yellow glass, they are perfectly excluded by green and red. This has suggested to photographers to substitute green glass for the yellow in the developing and fixing room. The yellow light is very trying to the eyes, while the green light is very agreeable.

Carey Lea recommends the green glass, after an experience in the preparation of hundreds of plates where it had been substituted for the yellow panes.

A NEW WINDOW.

The New York "Technologist" describes a new contrivance for preventing people looking into a room, while light is not excluded. It consists of a number of glass rods arranged either vertically or horizontally, and secured together by appropriate frames, forming a series of cylindrical lenses which break up the light and throw it into every part of the room, thus producing a soft and diffused glow which is very beautiful and pleasant. The glass rods may be of any color, and by an arrangement of the colors very beautiful effects can be produced. The contrivance is the invention of Mr. Demuth.

NEW DYE.

The "Engineer" states that the new dye known as soluble garnet seems to be coming more largely into use on the Continent, and as the colors produced with it are exceedingly brilliant, similar to those obtained with archil, but much more stable when exposed to light and air, the garnet dye is likely to become a great favorite. The dye was first prepared by Casthelaz, of Paris, and is the ammonia salt of isopurpuric acid, which is formed by the action of a metallic cyanide upon picric acid. It is not prepared from the pure crystallized, but from an inferior kind of picric acid, and is probably destined to replace the archil in many cases, in imparting to wool all shades, from garnet to chestnut-brown. It may be readily combined with other pigments, so that a number of different colors may be obtained. According to Casthelaz, the dyeing of wool and of silk is effected by the addition of an organic acid to the bath, for instance, acetic or tartaric acid, mineral acids being excluded. The dye-bath for silk should be cold or tepid in the beginning. Different shades in red and brown are thus obtained that are dependent upon the concentration of the bath, the nature of the mordant, and the time of the operation. — *Nature.*

FIBROUS COTTON-SEED.

Mr. Thomas Rose read a paper at the meeting of the British Association, "On the Utilization of Fibrous Cotton-Seed." He said that a vegetable production, which should be valuable, and could be supplied to the extent of millions of tons, was now wasted. The waste product was fibrous cotton-seed, and in America alone more than a million and a half tons of the seed were wasted yearly. The seed was composed of 50 per cent. kernel, which yielded about one-third oil, and 50 per cent. husk-shell with fibre adhering, of which the fibre would be one-third. His calculation was that the waste seeds would produce 250,000 tons of pure cotton, 250,000 tons of oil, and 500,000 tons of cattle-cake, the value of which he estimated at £20,000,000 sterling. The husks could be taken to the paper-mill and the cotton abstracted in such a manner as to form a most valuable material for paper. There was a process by which the cotton fibre could be completely separated from the shell; and the seed had a chief advantage, that of unfailing supply. In conclusion, Mr. Rose remarked upon the value and use of the oil and the cattle-cake that would be yielded by the seed.

EQUILATERAL TRIANGULAR DRAWING-BOARD FOR ISOMETRICAL DRAWING.

Mr. George Fawcus, of North Shields, has contrived an equilateral triangular drawing-board for isometrical drawing. An ordinary T square applied on the edges of an equilateral triangle draws tangents that meet each other at angles of 120°, and other lines drawn parallel to these radiating ones form with them angles of 60° and 120°, which are the exact angles of the apparent square of isometrical cubes. The inventor believes that the use of this new drawing-board will make the teaching of isometrical drawing both simple and easy. The practice of isometrical drawing is strongly urged in the science and art drawing classes. —*Nature.*

FIXING LEAD-PENCIL, CHARCOAL, AND CHALK DRAWINGS.

W. Wolanek states, that when the paper containing drawings or writings made with lead pencil, charcoal, etc., is painted over on the reverse side (where no writing or drawing exists) with a moderately strong solution of bleached shellac in alcohol the same becomes thoroughly fixed, so that they cannot be rubbed off. — *Journal Franklin Institute.*

NOVEL MECHANICAL MOVEMENT.

An exceedingly ingenious substitute, which can be scarcely called a modification, of the well-known joint of Dr. Hooke, has been patented within a year, by Mr. Melville Clemens, of Boston, an illustration and long description of which has been published in "Engineering," London, September 2, 1870.

Except to a very careful reader and student, this description is somewhat appalling (beside involving some errors of statement and calculation), and the drawings fail to show clearly or readily the principle on which it is constructed. In fact, the parts lie at such angles with each other, that neither drawings nor perspective will convey an adequate idea of the contrivance. It gives the full range of 90° to the angle at which the shafts (in the same plane of rotation) may have, and the motion transmitted is a uniform angular one, — both of which conditions are advantages not possessed by the Hooke joint.

If it is imagined that 2 shafts are placed in boxes or pedestals in the same plane, but at any angle with each other from 0° to 90°, the ends of which are tee-headed and placed at such distance apart that the tee-heads will clear each other (at 90°) in rotating; and if it is further supposed that each tee-head is made the axis or knuckle of 2 straps or triangular hinges, and the outer extremities of the hinges are connected (in pairs) with those which are attached to the opposite tee-head in a ball-joint, the whole forming a hinged parallelogram, the gist of the construction will be comprehended.

The ball-joint must allow a pestle and mortar motion of 10° to 15° and a rocking motion of 45°, and the knuckles on the tee-heads must rock 90° while the system rotates.

In a practical form for use the joints of this arrangement admit of as great strength as the Hooke joint, and the extreme range of angle to which it is applicable will render it available in many places.

The study of mechanical movements has occupied so many and so able persons, that the addition of a novel one bespeaks more than usual ingenuity; and this Clemens joint will at once take a place in the repertory of general information. — *Journal Franklin Institute.*

TRANSPORTATION OF FRESH MEATS AND FRUITS, ETC., THROUGH LONG DISTANCES. THE DAVIS REFRIGERATOR CAR.

The shell of the car consists exteriorly of the ordinary wood casing. A second wooden shell is made smaller than the first, and placed within it so as to leave an air space or chamber entirely around the top, bottom, and sides of the car. Within this second shell is placed a layer of hair, about 2 inches in thickness, and this again is lined with an interior wooden shell. This construction makes a non-radiating and non-conducting compound shell or case, of great power to resist the action of external heat, and renders the expenditure of ice quite small to maintain the required depression of temperature, after the interior of the car and its contents have been cooled down to the proper point, say from 34° to 38° Fah.

The refrigeration is accomplished in the following manner: Along the sides of the car are placed sheet-metal tanks shaped like the frustra of very gradually tapering wedges. They extend from the top to the bottom of the car, and are about 5 inches thick at the top and 2½ inches at the bottom. These tanks communicate at the top with the exterior of the car through funnel or hopper-shaped openings, and at the bottom through drip-pipes, which convey away the moisture. The funnel-shaped openings at the top are used for putting in the refrigerating mixture, consisting of broken ice and salt, and are provided with air-tight covers. The car is entered through a hatchway at the top, through which its freight is also introduced. This hatchway is also provided with a tight-fitting cover, made non-radiating and non-conducting, like the sides of the car.

The store of ice and salt for the trip is contained in a separate department in one end of the car, so that its contents can be reached, and the refrigerating tanks supplied, without opening the freight-room.

The freight is placed in the car on strips of board, strips of board also preventing its coming in contact with the walls of the refrigerating tanks. The packages are also so placed as to leave interspaces through, between, and around each. During the process of refrigeration the air circulates around the packages and along the sides of the tanks like water in a steam-boiler, the colder air falling, and the warmer air rising to the top, becoming chilled in its passage along the sides of the tanks, and depositing its moisture on the tanks till their sides are covered with a thick stratum of congealed water or hoar-frost. Thus the air is not only cooled but dried, no accession of moisture being derived from the external air or from the ice in the tanks, with either of which the interior of the car has no communication so long as the car is kept closed.

The two essentials for the preservation of substances liable to ferment, namely, absence of heat and of moisture, are thus secured in a very perfect manner, and the arrangement of the tanks is such that the space within the car for the storage of freight is not materially *reduced*. Some addition to the refrigerative mixture in the tanks is made each day, and the temperature is easily regulated and kept at the desired point by the addition of more or less salt in proportion to the charge of ice. — *Scientific American.*

PRESERVED FLESH IN AUSTRALIA.

The exportation of this article to England, according to the newspapers, is assuming great importance, and is becoming with wool one of the great staples.

The Victoria Company deprives the animal of its bones, skin, etc., salts it slightly, packs it in casks, filling the interstices with melted fat. Flesh thus preserved is said to keep excellently.

One company delivers weekly 40 tons of flesh.—*Condensed from Polytechnisches Centralblatt.*

PRESERVATION OF MEAT. BY M. GORGES.

The process in use on the large scale by the author, at Montevideo, is briefly as follows: The meat, in pieces weighing from 2 to 50 kilos, is placed in a mixture of water (85 per cent.), the rest being hydrochloric acid, glycerine, and bisulphite of soda. After having been steeped for some time, the pieces are taken out and dusted over with finely powdered dry bisulphite of soda, and then packed in air-tight boxes, filled as full as possible. In this state the meat keeps fresh any length of time, and becomes perfectly fit for use, equal to fresh butcher's meat, by steeping a short time in water, to which vinegar has been added, and afterwards exposed to air. The author manufactures, at the place above named, an excellent extract of meat, which can be sold in Europe at 6 francs per kilo. The price of the preserved meat, of which it would be easy to supply to London and Paris daily over 10 tons, is from 50 to 60 centimes per kilo. — *Journal Franklin Institute.*

NATURAL PHILOSOPHY.

SIZE OF ATOMS.

Sir William Thompson, who has been investigating regarding the probable size of molecules, has derived an important argument from electrical phenomena. He had previously proved that "a plate of zinc and a plate of copper, kept in metallic connection with one another, act electrically upon electrified bodies in their neighborhood, and upon one another, as they would if they were of the same metal and kept at a difference of potentials equal to about three quarters of that produced by a single cell of Daniell's. Hence, in connection with certain measurements on the electrostatic effects of that battery, it is found that plates of zinc and copper held parallel to one another at any distance, D, apart, which is a small fraction of the linear dimensions of their opposed surfaces, and kept in metallic communication with one another, exercise a certain force of attraction which can be calculated. From this we can calculate the work done if the plates approach each other from a distance, D′, till they are at this distance, D. Suppose, now, a pile composed of a great number of plates of zinc and copper kept in metallic connection while they are made to approach each other, their positions in the pile being parallel, and suppose for simplicity that their thickness is also D. We calculate the work done, estimating it by the height through which this energy would raise the whole pile, and giving different values to D we get varying values of this height according as the energy calculated by the formula varies. Down to values of D equal to one two hundred-thousandth of a centimetre the values of the energy computed are such that we may suppose that the laws of electrical attraction and induction are essentially the same as have been found for plates of measurable thickness at measurable distances from each other. But if D equals a very small amount, as one four-hundred-millionth of a centimetre, the computed energy is greater than that which converted into heat would melt the zinc and copper. So we must admit that as zinc and copper filings have no tendency to inflame on approaching one another, the electric attraction between plates one four-hundred-millionth of a centimetre thick, at a distance of one four-hundred-millionth of a centimetre from each other, must be much less than the amount calculated, supposing the ordinary laws still to be followed;" or, in other words, plates of zinc and copper, so thin as a four-hundred-*millionth of* a centimetre from each other, form a mixture closely approaching to a molecular combination, if indeed plates so thin could be made without splitting atoms.

The principles of capillary attraction lead to a similar result. It has been proved that the dynamic value of the heat required to prevent a body from cooling when stretched is rather more than half the work spent in stretching it. Hence, if we calculate the work required to stretch it to any extent, and multiply the result by three-halves, we have an estimate, near enough for the present purpose, of the augmentation of energy experienced by a liquid film when stretched and kept at a constant temperature. Taking .08 of a gramme weight per centimetre of breadth as the capillary tension of a surface of water, and therefore .16 as that of a water bubble, a quantity of water expanded to a thinness of one two-hundred-millionth of a centimetre would, if its tension remained constant, have more energy than the same mass of water in ordinary condition by about 1100 times as much as suffices to warm it by 1° Centigrade. This is more than enough to drive the liquid into vapor. Hence, if a film of one two-hundred-millionth of a centimetre can exist as a liquid at all, it is perfectly certain that it cannot be many molecules in thickness. The argument from the Kenetic Theory of gases leads to a similar conclusion, as do other electrical measurements. The result of the series of experiments first mentioned gives a certain result for the value (one four-hundred-millionth of a centimetre) there given, and a high probability that the limit is at least one two-hundred-millionth of a centimetre.

THE CONTINUITY OF THE GASEOUS AND LIQUID STATES OF MATTER.

Among the most important results of physical investigation recently obtained, are those of Dr. Andrews, on the continuity of the gaseous and liquid states of matter.

The transition from the gaseous to the liquid state, and from the liquid to the solid, has been regarded as necessarily abrupt, with the exception of the plastic condition assumed by some solids just before liquefaction. Dr. Andrews has shown that this is very far from being the case.

A series of experiments was undertaken by Dr. Andrews, in 1861, in which oxygen, hydrogen, nitrogen, carbonic oxide and nitric oxide were submitted to pressures greater than had previously been obtained in glass tubes, and while under this pressure they were submitted to the cold of the carbonic acid and ether bath. None of these gases exhibited any appearance of liquefaction, although reduced to less than one five-hundredth of their ordinary volume by the combined action of cold and pressure. A short time later a number of experiments were undertaken with carbonic acid, this being liquefied under certain fixed conditions of pressure and temperature.

These, together with some later researches, form the subject of the lecture of which this article is an abstract.

In the earlier experiments Dr. Andrews found that "on partially liquefying carbonic acid by pressure alone, and gradually raising at the same time the temperature to 88° Fahrenheit, the surface of demarcation between the liquid and the gas became fainter, lost its curvature, and at last disappeared. The space was then occupied by a homogeneous fluid, which exhibited, when the pressure was suddenly diminished or the temperature slightly lowered, a peculiar appearance of moving or flickering striæ throughout its entire mass. At temperatures above 88°, no apparent liquefaction of carbonic acid or separation into two distinct forms of matter could be effected, even when a pressure of 300 or 400 atmospheres was employed. Nitrous oxide gave analogous results."

In the later series, Dr. A. still made use of carbonic acid. In his apparatus the carbonic acid was contained in a glass tube, capillary in the upper and larger part of its length, and for the remainder of the widest bore in which the column of mercury would remain without displacement when the tube was placed in a vertical position. A movable column or bar of mercury confined the gas to be operated on. This glass tube was secured by careful packing in a massive end-piece of brass, which carried a flange by means of which a water-tight junction could be made with a corresponding flange attached to a cold-drawn copper tube of great strength. To the other end of the copper tube a similar end-piece was firmly bolted. The latter carried a fine steel screw, 7 inches long, which was packed with such care that the packing was capable of resisting a pressure of 400 atmospheres or more. Before commencing the experiment, the body of the apparatus was filled with water; the upper end-piece, carrying the glass tube in which was the gas to be operated upon, was firmly secured in its place, and the pressure was obtained by screwing the steel screw into the water-chamber. When the gas or liquid was exposed to very low temperatures, the end of the capillary-tube was made to dip into a bath of ether and solid carbonic acid under a bell-jar, from which the air could be exhausted.

In order to estimate the pressure in these experiments, a compound form of the apparatus was used, a second tube, containing air, being put in communication with the first, and used as a manometer. In order to keep the tubes at fixed temperatures, each was surrounded with a case, through which a current of water passed, by which the temperature could be regulated.

The temperature of the water surrounding the air-tube was kept stationary, coinciding with that of the apartment; that surrounding the carbonic acid tube was made to vary from 13.1° Centigrade to 48° Centigrade. The volumes of both air and gas were carefully read by a cathetometer.

The observations were recorded by the graphical method, being embodied in a series of curves. The air-curves are drawn for temperatures of 13.1° C., 31.1° C., and 48.1° C., the ordinates representing the volumes, and the abscissas the pressures.

In the carbonic acid curves for 13.1° C. there occurs an abrupt fall (diminution of volume) at a pressure of 49 atmospheres. The curve for 21.5° C. exhibits a corresponding fall, but not until a pressure of 60 atmospheres is reached. A slight deviation from perfect abruptness in the fall is shown by Dr. A., to result from the presence of a small quantity of air in the carbonic acid tube. The curve for 31.1° C. shows no such abrupt fall, but a rapid descent between the pressures of 73 and 75 atmospheres. This descent becomes gradually less marked as the temperature rises, and when a temperature of 48.1° C. has been obtained, it has almost, if not altogether, disappeared.

At any temperature between —57° C., and 30.92° C., carbonic acid, under the ordinary atmospheric pressure, is unquestionably in the state of a gas or vapor. On augmenting the pressure, the volume diminishes at a more rapid rate than that of a perfect gas, till liquefaction begins, a sudden diminution of volume then taking place. With some care it is possible to arrange the experiment so that part of the carbonic acid shall be in the liquid, and part in the gaseous state; the carbonic acid thus coexisting in two distinct physical conditions in the same tube and under the same external pressure. The result is, however, far different if the experiment be made at 30.92° C. or at any higher temperature. At this temperature, and under a pressure of about 74 atmospheres, the density of liquid and gaseous carbonic acid, as well as all their other physical peculiarities, are absolutely identical, and the most careful observation fails to discover any heterogeneity at this or higher temperatures in carbonic acid, when its volume is so reduced as to occupy a space in which at lower temperatures a mixture of gas and liquid would have been formed. The carbonic acid has, in fact, become one homogeneous fluid, which cannot by change of pressure be separated into two distinct conditions. This temperature of 30.92° C., Dr. Andrews calls the *critical point* of carbonic acid. Other gases show the same phenomena, but have different critical points. The rapid changes in density, which slight changes of temperature or pressure produce, when the gas is reduced at temperatures a little above the critical point, to the volume at which it might be expected to liquefy, account for the flickering movements referred to in the beginning of this article.

"I have frequently exposed carbonic acid," says Dr. Andrews, "without making precise measurements to much higher pressures than any marked in the tables, and have made it pass, without break or interruption, from what is regarded by every one as the gaseous state, to what is in like manner universally regarded as the liquid state. Take, for example, a given volume of carbonic acid gas at 50° C., or at a higher temperature, and expose it to increasing pressure till 150 atmospheres have been reached. In this process the volume will steadily diminish as the pressure augments, and no sudden diminution of volume without the application of external pressure will occur at any stage of it. When the full pressure has been applied, let the temperature be allowed to fall, till the carbonic acid has reached the ordinary temperature of the atmosphere. During the whole of this operation, no breach of continuity has occurred. It begins with a gas, and by a series of gradual changes, presenting nowhere any abrupt alteration of volume or sudden evolution of heat, it ends with a liquid. The closest observation fails to distinguish anywhere indications of a change of condition in the carbonic acid, or evidence at any part of the process of part of it being in one physical state, and part in another. That the gas has actually changed into a liquid would, indeed, never have been suspected had it not shown itself to be so changed by entering into ebullition on the removal of the pressure. For convenience, this process has been divided into two stages, the compression of the carbonic acid, and its subsequent cooling; but these operations might have been performed simultaneously, if care were taken so to arrange the application of the pressure and the rate of cooling that the pressure should not be less than 76 atmospheres when the carbonic acid had cooled to 31°.

"We are now prepared for the consideration of the following important question: What is the condition of carbonic acid when it passes, at temperatures above 31°, from the gaseous state down to the volume of the liquid, without giving evidence at any point of the process of liquefaction having occurred? Does it continue in the gaseous state, or does it liquefy, or do we have to deal with a new condition of matter? If the experiment were made at 100°, or at a higher temperature when all indications of a fall had disappeared, the probable answer which would be given to this question is that the gas preserves its gaseous condition during the compression, and few would hesitate to declare this statement to be true, if the pressure, as in Natterer's experiments, were applied to such gases as hydrogen and nitrogen. On the other hand, when the experiment is made with carbonic acid at temperatures a little above 31° C., the great fall that occurs at one period of the process would lead to the conjecture that liquefaction had actually taken place, although optical tests, carefully applied, failed at any time to discover the presence of a liquid in contact with a gas. But against this view it may be urged with great force, that the fact of additional pressure being always required for a further diminution of volume, is opposed to the known laws which hold in the change of bodies from the gaseous to the liquid state. Besides, the higher the temperature at which the gas is compressed, the less the fall becomes, and at last it disappears.

"The answer to the foregoing question, according to what appears to me to be the true interpretation of the experiments already described, is to be found in the close and intimate relations which subsist between the gaseous and liquid states of matter. The ordinary gaseous and ordinary liquid states are, in short, only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid, the transition, we have seen, may be accomplished by a continuous process, and the gas and liquid are only distant stages of a long series of continuous physical changes. Under certain conditions of temperature and pressure, carbonic acid finds *itself, it is* true, in what may be described as a state of instability, and suddenly passes with the evolution of heat, and without the application of additional pressure or change of temperature, to the volume which by the continuous process can only be reached through a long and circuitous route. In the abrupt change which here occurs, a marked difference is exhibited, while the process is going on, in the optical and other physical properties of the carbonic acid which has collapsed into the smaller volume, and of the carbonic acid not yet altered. There is no difficulty here, therefore, in distinguishing between the liquid and the gas. But in other cases the distinction cannot be made; and under many of the conditions I have described it would be vain to attempt to assign carbonic acid to the liquid rather than the gaseous state. Carbonic acid, at the temperature of 35.5°, and under a pressure of 180 atmospheres, is reduced to 0.480 of the volume it occupied under a pressure of one atmosphere; but if any one ask whether it is now in the gaseous or liquid state, the question does not, I believe, admit of a positive reply. Carbonic acid at 35.5°, and under 108 atmospheres of pressure, stands nearly midway between the gas and the liquid; and we have no valid grounds for assigning it to the one form of matter more than to the other. The same observation would apply with even greater force to the state in which carbonic acid exists at higher temperatures and under greater pressures than those just mentioned.

"In the foregoing observations I have avoided all reference to the molecular forces brought into play in these experiments. The resistance of liquids and gases to external pressure tending to produce a diminution of volume proves the existence of an internal force of an expansive or resisting character. On the other hand, the sudden diminution of volume, without the addition of external pressure, which occurs when a gas is compressed at any temperature below the critical point to the volume at which liquefaction begins, can scarcely be explained without assuming that a molecular force of great attractive power comes into operation, and overcomes the resistance to diminution of volume which commonly requires the application of external force. When the passage from the gaseous to the liquid state is effected by the continuous process described in the foregoing pages, these molecular forces are so modified as to be unable at any stage of the process to overcome alone the resistance of the fluid to change of volume.

"The properties described in this communication as exhibited by carbonic acid, are not peculiar to it, but are generally true of all bodies which can be obtained as gases or liquids. Nitrous oxide, hydrochloric acid, ammonia, sulphuric ether, and sulphuret of carbon, all exhibited, at fixed pressures and temperatures, critical points, and rapid changes of volume with flickering movements, when the temperature or pressure was changed in the neighborhood of those points. The critical points of some of these bodies were above 100°; and in order to make the observations it was necessary to bend the capillary tube before the commencement of the experiment, and to heat it in a bath of paraffine or oil of vitriol.

"The distinction between a gas and vapor has hitherto been founded on principles which are altogether arbitrary. Ether in the state of gas is called a vapor, while sulphurous acid in the same state is called a gas; yet they are both vapors, the one derived from a liquid boiling at 35°, the other from a liquid boiling at —10°. The distinction is thus determined by the trivial condition of the boiling-point of the liquid, under the ordinary temperature of the atmosphere. Such a distinction may have some advantages for practical reference, but it has no scientific value. The critical point of temperature affords a criterion for distinguishing a vapor from a gas, if it be considered important to maintain this distinction at all. Many of the properties of vapors depend on the gas and liquid being present in contact with one another; and this, we have seen, can only occur at temperatures below the critical point. We may accordingly define a vapor to be a gas at any temperature under its critical point. According to this definition a vapor may, by pressure alone, be changed into a liquid, and may therefore exist in presence of its own liquid; while a gas cannot be liquefied by pressure, that is, so changed by pressure as to become a visible liquid distinguished by a surface of demarcation from the gas. If this definition be accepted, carbonic acid will be a vapor below 31°, a gas above that temperature; ether a vapor below 200°, a gas above that temperature.

"We have seen that the gaseous and liquid states are only different stages of the same condition of matter, and are capable of passing into one another by a process of continuous change. A problem of far greater difficulty yet remains to be solved, — the possible continuity of the liquid and solid states of matter. But this must be a subject of future investigation; and for the present I will not venture to go beyond the conclusion, I have already drawn from direct experiment, that the gaseous and liquid forms of matter may be transformed into one another by a series of continuous and unbroken changes."

SUPERSATURATION.

Mr. J. G. Grenfell has described several interesting experiments, bearing on the theory of supersaturation. Professor Tomlinson supposes that a supersaturated solution adheres as a whole to a chemically clean surface, while to a chemically unclean surface the salt or gas adheres, while the liquid does not, thereby liberating the former. Grease is considered to be a cause of uncleanness. If, now, a greasy surface can be rendered inactive, either grease is not a cause of uncleanness, or unclean surfaces are not necessarily inactive. A number of experiments were tried, in which a drop of melted fat was allowed to fall on a supersaturated solution, without causing solidification even upon agitation of the liquid, while a minute crystal of the salt caused instant solidification. Mr. Tomlinson's explanation, then, would seem to be inadequate. M. Gerney believes that only a crystal of the same salt can induce crystallization, a view necessitating our believing that all salts capable of supersaturation are everywhere present in the atmosphere. Some other experiments seem to show that a supersaturated solution may remain unchanged for a long time in an atmosphere saturated with the same salt. We must probably conclude that supersaturated solutions really contain the anhydrous salt in a state of unstable equilibrium, only requiring a disturbance to cause it to assimilate water, and thus produce a less soluble compound. Prof. Tomlinson, in a later paper, considers oils and fatty matters as chemically clean when they contain no matter foreign to their composition. The oils, however, whether clean or not, seem to act as powerful nuclei when in the form of thin films. He also remarks regarding M. Gerney's views that when that physicist so carefully prepared his nuclei as to be absolutely free from salt, he also made them chemically clean.

VELOCITY OF SOUND.

M. André, in "Comptes Rendus," gives an account of some experiments made by him relative to the velocity of sound in water contained in a cast-iron conduit. Having the charge of laying a tubular conduit, which had to be tested by pressure when filled with water, it occurred to him to make some fresh measurements on the velocity of sound in that medium. The conduit consisted of cast-iron tubes of 0.8 metre internal diameter and 0.02 metre thick, forming when joined a straight line of about 600 metres. The motions of the liquid were recorded by means of a kind of pneumatic register, the disturbance communicating itself to the air confined in a small caoutchouc tube, and thence to a membrane of gold-beater's skin. A very delicate lever fastened to this membrane indicated, by its oscillations, the slightest movements of the liquid. The time was measured by means of a tuning-fork, which inscribed its vibrations on the blackened sheet of a registering cylinder. This tuning-fork gave for a temperature of 20°, 256 vibrations per second.

A series of experiments was first performed to ascertain the velocity in air using the same apparatus, and producing the sound by means of a pistol charged with one gramme of powder. The shock communicated to the air of the conduit was propagated through the whole length of the tubes, and then returned after reflection. At each successive departure and return, the style of the membrane gave very distinct indications on the registering cylinder.

The temperature of the air in the tubes was 40° at one end and 20° at the other, as they were laid in an open trench upon part of which the sun shone. Taking these two numbers as extreme limits of temperature, the velocity of sound ascertained when reduced to zero was,

$$V_0 = 326.60 \text{ metres, if temperature was } 40°;$$
$$V_0 = 337.50 \text{ metres, if temperature was } 20°.$$

It is certain that the first number must be nearer the truth than the second; for the part of the tubes exposed to the sun was considerably greater than that in contact with the cold ground.

The interior being filled with water and completely freed from air, experiments were made on the velocity in water. The shock was produced by suddenly forcing in the piston of a hydraulic press. However rapidly the pump-lever was lowered, no shock, properly so called, was produced, but a gradual compression; thus the indication of the style upon the register, instead of being a well-defined zigzag, as in the case of air, traced an elongated curve, of which the point of coincidence with the spiral inscribed by the style at rest was difficult to determine.

Four successive experiments gave a mean of 345 vibrations of the tuning-fork between the initial and return shocks. The length of the conduit between the two plates which closed the extremities was 603.25 metres; hence the distance travelled by the compression between departure and return was 1,206.5 metres. The temperature of the water at the top of the conduit was 20°, and 13° at the bottom. The temperature of the surrounding air was 18°. Under these circumstances the velocity of the compression was found to be 897.80 metres per second.

Wertheim deduced from the sound given by brass organ-pipes dipping in water, 1,173 metres per second as the velocity of sound in water. This number is much less than 1,435 metres per second, found by M.M. Colladon and Sturm, in direct experiments made on the Lake of Geneva.

The value which M. André found is still further from the number observed in an indefinite mass of water.

The author calls the attention of physicists to the influence which the elasticity and friction of the containing sides may have on the propagation of a shock in the midst of an almost incompressible fluid.

FIXED NOTES CHARACTERISTIC OF THE VARIOUS VOWELS.

BY M. R. KOENIG.

"According to the researches of MM. Donders and Helmholtz, the mouth, arranged for the emission of a vowel, has a note of stronger resonance, which is fixed for each vowel, whatever may be the fundamental note on which it is given. A slight change in the pronunciation modifies the vocal notes so sensibly that M. Helmholtz has been able to propose to linguists to define by these notes the vowels belonging to the different idioms and dialects. Hence it is of great interest to know exactly the pitch of these notes for the different vowels. M. Donders sought to arrive at this by observing the rustling or whistling which the current of air produces in the mouth when the different vowels are whispered; the notes which he has found differ considerably from those given by M. Helmholtz. The latter used a set of tuning-forks, which he made to vibrate in front of the mouth when it was arranged to articulate a vowel. Every time the sound was strengthened by the air enclosed in the cavity of the mouth, this mass of air was evidently in unison with the tuning-fork. By this method, which is more correct than the first, M. Helmholtz found that the vowel A was characteristic by the fixed note (si b)$_4$, O by (si b)$_3$, E by (si b)$_5$, and these results really appear incontestable. As none of the tuning-forks arranged was sufficiently acute for the vowel I, M. Helmholtz tried to determine the characteristic note by the means already employed by M. Donders, and found it to be re$_6$. If a tuning-fork be tuned for this note, we ascertain, in fact, that it is increased whilst the mouth passes from E to I, — at least I have been able to assure myself that the increase occurs before the mouth is exactly arranged for I. Hence the time characteristic of I must be higher. By constructing tuning-forks more and more acute, I ascertained that this note was approached; it was finally found to be (si b)$_6$; with tuning-forks still higher it is immediately felt that the limit has been passed.

"For OU, M. Donders has given fa$_3$. This note can undoubtedly be strengthened by the mouth, but it is only in departing very little from the position O, and one feels that the note for OU must be much more grave. M. Helmholtz assigns fa$_2$ to OU. However a tuning-fork, fa$_2$, does not resound before the mouth arranged for OU, which M. Helmholtz accounts for by the smallness of the opening of the mouth; but it seemed to me that this smallness of the opening, while rendering a very energetic increase impossible, must still admit an appreciable increase in the intensity of the sound. Having, moreover, ascertained the simple ratios which exist between the notes of the vowels, O, A, E, I, ascending by octaves, I thought that this law would extend to the vowel OU. I verified this hypothesis circumstantially by means of a tuning-fork, the pitch of which could be raised by means of slides; I was thus able to assure myself that the characteristic note of OU (as I ordinarily pronounce it) was really (si b)$_3$; for the maximum of resonance always occurred between 440 and 460 simple vibrations.

"For the pronunciation of the Germans of the North (to which the experiments of M. Helmholtz also refer), the vowels are then characterized as follows: —

OU	O	A	E	I
(si b)$_2$	(si b)$_3$	(si b)$_4$	(si b)$_5$	(si b)$_6$;

or, in round numbers of simple vibrations, 450, 900, 1800, 3,600, 7,200.

"It seems to me more than probable that we must seek in the simplicity of these ratios the physiological cause which makes us find nearly always the same five vowels in the different languages, although the human voice can produce an indefinite number, as the simple ratios between the numbers of vibrations explain the existence of the same musical intervals among most nations." — *Philosophical Mag. from Comptes Rendus.*

NEW MODE OF HEATING STONE–WARE VESSELS.

Mr. J. A. Coffey has patented a new method of heating stone*ware vessels* and of obtaining regulated high temperatures, which will be of value in manufacturing chemistry. The principle is to cause a current of heavy paraffine oil to circulate, first through a coil of pipes in a furnace, and then through the jackets of the pans. It moves by its own convection. Any temperature from 100° to 700° Fahrenheit can easily be obtained. As contrasted with steam heat, the inventor claims for his process a saving of 30 per cent. in fuel, the large amount of heat necessary to convert water at 212° into steam being economized.

DEEP-SEA THERMOMETERS.

Capt. Richards, R.N., Hydrographer of the Admiralty, has made a number of experiments regarding the inaccuracy of thermometric measurements at great depths. As it is well known that a delicate thermometer is affected in vacuo, it was naturally supposed that an opposite effect would take place under increased pressure. The experiments were performed with a hydraulic press. Previous to the experiments, Dr. W. A. Miller proposed a mode of protecting the bulb from compression by encasing the full bulb in glass, the space between the case and bulb being nearly filled with alcohol. A wrought-iron bottle had been made to contain a thermometer, for the purpose of comparison with those subjected to compression, but it burst under the great pressures employed. Those designed by Dr. Miller, however, showed so little difference under pressure that they were received as standards. Two series of experiments were then made at pressures equal to depths of 250, 500, etc., to 2,500 fathoms, the results of which satisfactorily proved that the strongest-made unprotected thermometers are liable to considerable error, and therefore that all previous observations made with such instruments are incorrect. Experiments were also made in the testing apparatus, with Sir William Thompson's enclosed thermometers, to ascertain the calorific effect produced by the sudden compression of water, in order to find what error, if any, was due to compression in the Miller pattern. An error was proved to exist, but small, amounting to no more than 1.4° under a pressure of 3 tons to the square inch. The dredging cruise of the "Porcupine" afforded an opportunity of comparing the results of the experiments made in the hydraulic testing apparatus with actual observation in the ocean. The result was, that though there was a difference in the curves drawn from the two modes of observation, still the general effect was the same, and the *means* of the two were identical. From these experiments and observations a scale has been made, by which observations made by thermometers of similar construction to those with unprotected bulbs can be corrected and utilized. It is suggested, that to avoid error from the unsatisfactory working of the steel indices of self-registering thermometers, two instruments should be sent down at each observation; and, although their occasional disagreement of record may raise a doubt, a little experience will enable the observer to detect the faulty indicator, while their agreement will create confidence.

EMISSION, ABSORPTION, AND REFLECTION OF VARIETIES OF HEAT RADIATED AT LOW TEMPERATURES.

Magnus has communicated an interesting and valuable paper on the heat radiated at low temperatures, and on the absorption and reflection of such rays. The results of this investigation — the last, we suppose, made by the lamented author — are, so far as published, in his own words as follows: —

"(1.) Different bodies at 150° C. radiate different kinds of heat. These kinds of heat are more absorbed by a substance of the same kind as the radiating body than by others, and this absorption increases with the thickness of the absorbent.

"(2.) There are substances which emit only one or a few kinds of heat, others which emit many kinds.

"(3.) To the first of these belongs rock salt when quite pure. Just as its ignited vapor, or that of one of its constituents, sodium, radiates but one color, so rock salt, even at a low temperature, emits but one kind of heat. It is monothermic, as its vapor is monochromatic.

"(4.) Rock salt, even when quite clear, emits, together with its peculiar rock-salt heat, heat which is not more absorbed by a plate of rock salt 80 mm. in thickness than by one 20 mm. in thickness.

"(5.) Rock salt absorbs very powerfully the heat which it radiates. It therefore does not, as Mellari supposed, allow all kinds of heat to pass through it with equal facility.

"(6.) The great diathermancy of rock salt does not depend upon its less power of absorption for different kinds of heat, but upon the fact that it radiates only one kind of heat, and consequently absorbs only this one, and that almost all other substances send out heat containing only a small fraction or more of the rays which rock salt emits. But all rays which differ from those radiated by any substance are not absorbed by it, but pass through with undiminished intensity.

"From this we may infer that any substance is diathermanous, only because it radiates but few waves of quite definite length, and consequently absorbs only these, allowing all the others to pass through.

"(7.) Sylvin behaves like rock salt, but is not monothermic to the same extent. In the case of this substance also, an analogy exists with its ignited vapors, or those of potassium, which, as is well known, yield a nearly continuous spectrum.

"(8.) Fluor-spar completely absorbs pure rock-salt heat; we ought, therefore, to expect that the heat which it emits will be equally absorbed by rock salt. Nevertheless, 70 per cent. of this heat passes through a rock-salt plate 20 mm. in thickness. This may doubtless be easily explained with reference to the quantity of heat which fluor-spar emits in comparison with that of the rock salt; still it is possible that fluor-spar at 150° emits rays other than those which it absorbs at ordinary temperatures. This behavior is probably connected with the great reflecting power of fluor-spar for rock-salt heat.

"(9.) If it were possible to produce a spectrum of the heat radiated at 150° C., the spectrum would, if rock salt were the radiating body, exhibit only one luminous band. If sylvin were used as a radiator, the spectrum would be much more extended, but would still occupy but a small portion of the spectrum which the heat reflected from lamp-black would form."

In concluding this part of his memoir Magnus makes some remarks on transparency, which seem to us very suggestive. If we assume that there is a constant interchange of heat even between bodies having the same temperature, we may fairly assume also that there is such an exchange in the case of light. We cannot observe the light which bodies emit, at ordinary temperatures, but they do not absorb light, since this absorption produces their colors. If such an exchange of light takes place at ordinary temperatures, it would follow that transparent bodies either radiate only such rays as are not contained in the light emitted by ignited bodies, and then they absorb none of these rays, or they emit only one or a few of the wave-lengths of the light which is visible to us. Since, then, they absorb only these, and allow all others to pass through, so that the intensity of the transmitted light is but little less than that of the incident light, we may therefore infer that the transparency of bodies depends upon the fact that they radiate only a few of the wave-lengths, which are contained in the light known to us. — *Silliman's Journal, from Poggendorff.*

USE OF THE ELECTRIC CURRENT IN CALORIMETRY.

BY M. J. JAMIN.

"Joule's Law gives the heat which is developed in conductors when traversed by currents. A metal wire may be regarded as a focus. It may have any possible form and be placed where we please, in the midst of liquids or gases; a quantity of heat will be given off proportional to the time, to its resistance, and to the square of the intensity of the current. It will heat these bodies by a quantity that can be measured, and which is inversely proportional to their mass and to their specific heat. Hence results a new process to determine this specific heat. After numerous trials I fixed upon he following arrangements: —

"I. *Case of Solids and Liquids.* — In dealing with a solid or a liquid, I use as a calorimeter an elongated cylindrical vessel of thin copper, on which is coiled 8 metres of German-silver wire 0.2 millim. in diameter, and covered with silk. This spiral commences at the bottom of the vessel, and ascends to one-third of its height; it is connected with the circuit by thick copper wires; its resistance is measured for all the temperatures of the experiment. I envelop it with a thick silk ribbon to keep it in its place, some swan's down to insulate it, and I enclose the whole in an envelope of thin copper polished. When the calorimeter contains a liquid, and a current is caused to pass through the spiral, nearly all the heat will be transmitted to the side, then to the liquid; a scarcely appreciable portion will be transmitted to the swan's down.

"With this view, fresh liquid must continually be brought into contact with the sides by uniform agitation. For this purpose, a basket of metal gauze, formed of 2 concentric tubes, is immersed in the calorimeter. A small machine raises it and lowers it at equal intervals; a thermometer marking the hundredth of a degree is immersed in the central tube; it is fixed, and is read with a telescope. When the specific heat of solids is to be measured, they are placed in the basket in the water.

"This constitutes the entire apparatus; the operation is one of extreme simplicity. After pouring into the calorimeter the weight of liquid which is to be investigated, and agitating it for some time, the variation (if any) of the thermometer is observed for 5 minutes. Generally it does not vary. A current of measured intensity is then made to pass during 1, 2, etc., minutes, until an elevation of 3 or 4 degrees is produced; this is noted, after which the cooling of the thermometer is observed during 5 minutes. The quantity of heat given off is known, the effect it has produced is calculated, and from the known formulæ of calorimetry the desired capacity is deduced. Thus, suppose two experiments to be made with the same current during the same time, with the weights P and P' of water and of the liquid to be studied. The quantities of heat are the same; they have heated the liquids θ and θ' degrees. Denoting the weight of the calorimeter reduced to water equivalents by π, and the capacity sought by x, we have $(P + \pi)\,\theta = (P'x + \pi)\,\theta'$, from which x can be calculated.

"The old method required two operations, which were, the first, to heat in a stove for a long time the body to be studied, and to pour it, with minute precautions, into the calorimeter; the second, to observe the thermometer immersed in the calorimeter. In the method which I propose the first operation is omitted, and the second suffices such as it was before. The corrections remain the same, but are simplified.

"They are simplified, because a lower temperature is sufficient, and because the heat given off being proportional to the time, the method known as Rumford's is applicable. We may even dispense with all correction, as I shall show.

"I provided the external envelope of the apparatus with a spiral 20 times as long as the first, and immersed the whole in a vessel containing 20 times as much liquid as the calorimeter, and forming a medium in which the latter is immersed. The current passes simultaneously into the 2 spirals; it produces there heats proportioned to the quantities of liquids, and consequently equal heatings. At each moment the temperatures of the calorimeter and its surroundings are in equilibrium, and the first, neither losing nor gaining anything by radiation, is subject only to the action of the current. It is impossible to maintain this equilibrium strictly during the whole time of the experiments if they are prolonged; but it is very easy to establish it within a few tenths; and this is sufficient to obviate all necessity for correction. Thus we can measure for each degree the specific heat of a liquid (water or alcohol, for example) from the lowest temperatures to its boiling-point.

"I have verified this method by determining the capacities of iron and of copper, which are the most difficult to obtain exactly, because they are very small. I found 0.098, 0.093. M. Regnault obtained the numbers 0.113, 0.095, which are a little larger; but he operated with a higher temperature.

"II. *Of Gases and Vapors.* — The advantages of this method are especially apparent when treating of aeriform fluids. A gaseous current passes through a glass tube to the middle of a cork of badly conducting material; a thermometer there measures its temperature. It immediately enters a second tube through the folds of a metal spiral or a bundle of twisted wires traversed by electricity, that is to say, through a focus; it becomes heated and meets a second thermometer, which measures its increase of temperature. Before emerging, the gas is led round the first tube, to prevent any loss by radiation and conductibility; and when the temperature has become stationary, we may say that all the heat of the focus, which is known, is taken by the gas, the temperature of which is increased by a measured quantity; hence the specific heat can be deduced.

"There are two advantages in this method. The first is, that the greatest cause of error which Delaroche and Bérard, and afterwards M. Regnault, met with, is suppressed. In their experiments the gas reached 100° in a calorimeter at 10°; and the greatest difficulty was felt in appreciating the heat which passes by conductibility from the hot tube to the cold calorimeter. In my method the gas reaches, at the ordinary temperature, say 10°; it passes from the spiral at about 20°; the difference is 10°; it was 90° before; the present error is at most one-ninth of the former.

"Here is the second improvement. The whole of my apparatus is the size of a finger; it is of thin glass; it might be of mica, — even of goldbeater's skin; it weighs no more than a litre of gas, and expends no more heat in reaching the final temperature. Ten litres of gas are sufficient to make one measurement. Thus the difficulties that had for a long time to be overcome, in order to obtain a uniform current, disappear, ordinary gasometers suffice, and the method is applicable even to vapors. A first determination gave the number 0.242 for air instead of 0.237, which M. Regnault found.

"Thermometers, even, may be dispensed with, and the temperature measured by the increase of resistance in the wires. It is known that a resistance r at zero becomes $r\ (1 + at)$ at t degrees. That being the case, let 2 equal bundles of wires be placed one after another in a tube; then, having decomposed the total circuit into 2 equal derived circuits, let us make each of them pass, first, through 1 of the 2 bundles of wires, then into a differential galvanometer; the latter remains at zero. But if a current of gas at t degrees be sent through this tube, it will pass at $t + \theta$ in the first spiral, at $t + 2\theta$ in the second; they take a difference of temperature θ, a different resistance, and the galvanometer is deflected. It is reduced to zero on introducing, by means of a special rheostat, a platinum wire into one of the circuits. The length of this wire is proportional to the increase of temperature θ; it admits of measurement.

"The same apparatus is applicable to vapors. The liquid to be examined is distilled as regularly as possible; the current of vapor is at first superheated by the first bundle of wires; it afterwards traverses the second, becomes heated by a quantity θ, which is measured as before; the vapor is condensed, and afterwards weighed. In order to take into account the irregularities of the distillation, it is necessary to observe the apparatus from minute to minute.

"III. *Latent Heat.* — In order to measure latent heats, a double alembic is employed, of which one part is exterior; the liquid in it is caused to boil, and the vapor is brought there after having been condensed by a refrigerator; the effect of this is simply to raise to the boiling temperature the interior alembic, which contains the same liquid, and in which is immersed the spiral, the resistance of which is known for every temperature. The vapor which forms in the second apparatus is collected during 10 minutes before the passing of the current; there is scarcely any; the circuit is then closed which determines a rapid boiling. The heat supplied is known; the vapor which it has formed without change of temperature is weighed, and the latent heat is deduced.

"IV. *The two Specific Heats.* — A third application of the same principle can be made. In a large bell-glass filled with air, a metal wire is stretched; an intense current is passed for a short time through it, which develops a determined quantity of heat; a fraction of this disappears by radiation; the remainder, which is constant, gives heat to the gas, which can be measured in two ways, — either by increase of the volume at constant pressure, or by increase of the pressure at constant volume. From these two effects the ratio of the two specific heats can easily be determined, and the number found is about 1.42, a number indicated by the velocity of sound." — *Comptes Rendus, trans. in Phil. Mag.*

SUDDEN BREAKING-UP OF ICE.

A letter from Canada, in "Nature," for June 23, gives some curious facts regarding the sudden breaking-up of ice covering lakes and rivers. "The ice on our inland lakes is generally 2 or 3 feet thick. As the spring advances, an inch or two may be melted away from the lower surface, and somewhat more from the upper one, but the thickness is not materially reduced until its final disappearance. The first sign of the approaching break-up is that the ice becomes dry, from the prismatic structure having commenced to show itself, allowing the surface water to percolate through the interstices; it is then said to be honeycombed. In this state the lower layers of transparent ice are still solid, though if you cut out a block the prismatic structure is very evident; but the upper portion, which has been formed from a *mixture of snow* and water, readily breaks up under your feet into little granules of ice. The next stage is that the ice becomes black, showing that it is soaked, as it were, with water; and if at this time there is any open water, as where a river falls into a lake, and wind enough to produce a swell, the whole surface of the ice may be observed to undulate. If the ice now breaks up prematurely with a high wind, it becomes a mass of spiculæ of ice which have not reached the melting-point, and which I have seen accumulated to the depth of 6 or 7 feet against the edge of the ice which has not yet broken up. But if there is no wind the whole surface of the lake may appear an unbroken sheet of black ice, still a couple of feet thick, till, in an astonishingly short time, sometimes not more than a few minutes, it disappears as if by magic. So sudden is this disappearance that the ice is popularly believed to sink.

"I once had a very good opportunity of noticing this sudden disappearance. I had built on the ice during the winter a pier of logs filled with stones, and when the spring came it settled down to the bottom, carrying with it a large cake of the ice. When the lake had opened, I went round the pier in my canoe to see if it had settled evenly. There, at the bottom, in 6 or 7 feet of water, lay the cake of ice it had carried down, with the chips made in building the pier still imbedded in it; and, as I looked, blocks would break off, of a foot or more in thickness, rise to the surface, and almost instantaneously disappear. . . . . The true explanation of the prismatic structure appears to me to be the lines of air-bubbles. These are visible in all ice before any thaw has commenced, and in the process of freezing they seem to be formed in vertical lines. When the thaw occurs these lines of bubbles form the centres, as it were, from which it penetrates in every direction through the mass."

REFRACTION AND DISPERSION OF OPAQUE BODIES.

The results of a research on the relation of the refractive indices and dispersion of opaque bodies, published in Poggendorff's "Annales," by Wernicke, are thus given by the author: —

The examination of thin plates giving colors by interference, leads to the conclusion "that all bodies of strong dispersion have optical properties in common, which appear of interest for the theory of light.

"It is known from experience that dispersion and absorption are related to one another; and Cauchy, in his 'Memoire sur la dispersion de la Lumière,' has given an equation in which this relation is implicitly contained. The discussion of this equation, of which one side is an infinite series, presents some difficulties; it has been thought sufficient to retain the first two terms of this series, and neglect the rest. This would be permissible, as M. Christoffel has shown, if in every case the sphere of action were infinitely small in comparison with the wave-length. That the last assumption is not admissible, however, the discussion of the incomplete equation shows; for it yields the result that every spectrum is bounded at the violet end by a visible beam of definite refraction. This inference is a physical absurdity, since it presupposes the existence of bodies, which, under any arbitrary angle of incidence, totally reflect a visible beam, or completely absorb it on the surface. The dispersion-formula derived from the imperfect series, even if correct for large wave-lengths, can offer no explanation as to what really occurs at that limit at the more refrangible end of the spectrum.

"While this limit, with substances of weak dispersion, would lie very far in the ultra-violet, it sometimes appeared in the green in the bodies which I investigated. With no single body of this group were even traces of interference observed in the violet. The reason of this phenomenon might be sought in a strong reflection of these rays at the surface, or in a strong absorption in the interior. It has been shown that the latter is the preponderating cause of the absence of interference-bands. Then they always vanish gradually with increasing thickness, from the violet to the red end of the spectrum, and are very soon only present in the yellow and red. *Hence the absorption increases with decreasing wave-lengths, and, indeed, continuously so for a certain position in the spectrum, which is special to each substance,* and so quickly that on the other side of it no ray can pass through a layer of the thickness of half a wave-length.

"*Hence, in transmitted light sufficiently thick layers of bodies of pre-eminent dispersion always appear yellow-red or red.* I have sought in vain for a substance of this kind which would be transparent with green, blue, or violet light.

"To meet any objections to these matters of fact arising from the mention of apparent exceptions, I must make the following remarks: —

"Thin layers can be prepared in different ways, which strongly absorb the light, and are transparent to other than yellow or red light; such layers, however, like glass coated with soot, are not to be regarded as bodies, but as loosely connected apparatus of individual particles, and can only be quoted as exceptions if it be proved generally that they possess refractive and dispersive properties. For example: let chlorine, bromine, iodine, sulphur-vapor, or sulphuretted hydrogen act on thin layers of silver; then thin layers of chloride, bromide, iodide, or sulphide of silver are formed, which, in comparison with the metals and metallic oxides described, are very transparent, and show in the spectroscope beautiful interference-bands. If, however, the intensity or duration of the action of these agents exceeds a certain limit, the structure of the layers is destroyed; the same are then to be regarded as aggregates of many particles (in several cases microscopic crystals), although they appear to the eye as coherent masses; they are more opaque than the metal itself, and show no trace of interference-bands in the spectroscope." —*Philosophical Magazine.*

BREADTH OF SPECTRAL BANDS.

Lippich has attempted the application of the dynamical theory of gases and vapors to the explanation of the breadth of the bands of gaseous spectra. The assumption made is that "if it be necessary to consider a molecule as a system capable of vibration, the spectrum of an ideal gas in which the molecules could be perfectly free elastic systems could consist only of a number of differently colored bands of homogeneous light if the vibratory motions of the molecules alone be taken into account." But as, according to the theory of Clausius, the molecules have also very rapid progressive motions, the refrangibility of the rays produced will depend upon the combination of the vibratory and progressive velocities, thus showing the dependence of the breadth of the bands upon the temperature and density of the ignited gas. The author gives a law regarding the ratio of the mean and extreme wave-lengths of the bright bands and dark lines of the same and different gases.

The comparison of the relative breadth of bands may lead to some important conclusions. The proximity of bands of different breadths in any spectrum may indicate the presence of gases of different densities or of the same gas in different allotropic states. For example, the faint blue lines in the oxygen spectrum may indicate the presence of the denser ozone. The breadth of the spectral bands in the same gas will permit a conclusion as to the temperature, a fact useful in stellar spectroscopy, there being noticeable differences in the breadth of the hydrogen bands. The author remarks finally that his conclusions apply only to perfect gases, and changes from these to vapors will be noticed by changes in their spectra.

INTENSITY OF ACTINISM AT DIFFERENT ALTITUDES.

A paper has been presented to the Royal Society by Messrs. Roscoe and Thorpe, giving the results of a series of determinations of the chemical intensity of total daylight under different altitudes of the sun. The experiments were made on a flat table-land near Lisbon. The method used was founded on the exact estimation of the tint which standard sensitive paper assumes when exposed for a given time to the action of daylight. The experiments were made as follows: —

1. The chemical action of daylight was observed in the ordinary manner.
2. The chemical action of the diffused daylight was then observed by throwing on to the exposed paper the shadow of a small blackened brass ball placed at such a distance that its apparent diameter, seen from the position of the paper, was slightly larger than that of the sun's disc.
3. Observation No. 1 was repeated.
4. Observation No. 2 was repeated.

The mean of *observations* 1, 2, 3 and 4 was then taken.

The sun's altitude was determined by a sextant and artificial horizon immediately before and immediately after the observations of chemical intensity, the altitude at the time of observation being ascertained by interpolation.

One of the 134 sets of observations was made as nearly as possible every hour, and they thus naturally fall into 7 groups, viz.: —

(1) Six hours from noon, (2) 5 hours from noon, (3) 4 hours from noon, (4) 3 hours from noon, (5) 2 hours from noon, (6) 1 hour from noon, (7) noon. Each of the first 6 of these groups contains 2 separate sets of observations (1) those made before noon, (2) those made after noon. It has before been pointed out, from experiments made at Kew, that the mean chemical intensity of total daylight for hours equidistant from noon is the same. The results of the present series of experiments prove that this conclusion holds good generally; and a table is given showing the close approximation of the numbers obtained at hours equidistant from noon.

Curves are given showing the daily march of chemical intensity at Lisbon in August, compared with that at Kew for the preceding August, and at Pará for the preceding April. The value of the mean chemical intensity at Kew is represented by the number 94.5, that at Lisbon by 110, and that at Pará by 313.3 light of the intensity 1 acting for 24 hours being taken as 1000. The following table gives the results of observations arranged according to the sun's altitude: —

No. of Observations.	Mean Altitude.		Chemical Intensity.		
	°	′	Sun.	Sky.	Total.
15	9	51	0.000	0.038	0.038
18	19	41	0.023	0.063	0.086
22	31	14	0.052	0.100	0.152
22	42	13	0.100	0.115	0.215
19	53	09	0.136	0.126	0.262
24	61	08	0.195	0.132	0.327
11	64	14	0.221	0.138	0.359

Curves are given, showing the relation between the direct sunlight (column 3) and diffuse daylight (column 4) in terms of the altitude. The curve of direct sunlight cuts the base line at 10°, showing that the conclusion formerly arrived at by one of the authors is correct, and that at altitudes below 10° the direct sunlight is robbed of almost all its chemically active rays. The relation between the total chemical intensity and the solar altitude is shown to be represented graphically by a straight line for altitudes above 10°, the position of the experimentally determined points lying closely on the straight line.

A similar relation has already been shown to exist (by a far less complete series of experiments than the present) for Kew, Heidelberg, and Pará; so that although the chemical intensity for the same altitude at different places and at different times of the year varies according to the varying transparency of the atmosphere, yet the relation at the same place between altitude and intensity is always represented by a straight line. This variation in the direction of the straight line is due to the opalescence of the atmosphere; and the authors show that, for equal altitudes, the higher intensity is always found where the mean temperature of the air is greater, as in summer, when observations at the same place at different seasons are compared, or as the equator is approached, when different places are examined. The differences in the observed actions for equal altitudes, which may amount to more than 100 per cent. at different places, and to nearly as much at the same place at different times of the year, serve as exact measurements of the transparency of the atmosphere.

The authors conclude by calling attention to the close agreement between the curve of daily intensity, obtained by the above-mentioned method at Lisbon, and that calculated for Naples by a totally different method. — *Philosophical Magazine, July*, 1870.

PHOTOGRAPHY AND MOLECULAR PHYSICS.

Mr. Harrison, in "Nature," calls attention to the facilities offered for studying molecular physics in connection with the mechanical operations connected with photography. If 3 collodionized plates be dipped, one in a solution of oxide of cadmium, the second in a solution of bromide of cadmium, the third in a solution of chloride of cadmium, as is done in "iodizing" the plate, and each then sensatized by immersion in a bath of nitrate of silver, the third will take longer than the second to become covered with a film of silver salt, and the second longer than the first. Also, the exposures to light in the camera when used for taking a picture are in the same order. These differences in time of exposure may, perhaps, be accounted for on the supposition that the chlorine binds itself to silver with more force than is exerted by bromine, and that the bromine clings to the silver with more force than the iodine, so that the waves of light have more work to do in heating the chlorine from the silver than in separating the bromine or the iodine. An experiment by Mr. M. Carey Lea, of Philadelphia, shows that the atoms separated by light may recombine in darkness. He prepared a film of dry iodide of silver, on exposing which under a negative, a picture was formed, which came out on developing with "alkaline developer." If, however, instead of developing the picture, it was left in darkness for a few days, the latent image died out, and a new picture could be taken on the sensitive surface.

MICROSCOPIC PHOTOGRAPHY.

A very successful series of experiments on the production of photo-micrographs, by means of artificial light, has been conducted by Col. Woodward, of the Army Medical Museum, Washington, from the published report of which the following sketch was made.

During the latter part of 1869, Col. Woodward began a series of experiments with the design of removing certain difficulties in the photographing of tissues on a large scale. The solar light was used, and little difficulty was found in arranging a method which gave most excellent results. Great annoyance was caused, however, by the uncertainty of the weather, there being but few days suitable for working to advantage. This led Col. W. to seek some other means of illumination, and by the use of the electric, magnesium, and lime lights he has succeeded in producing photo-micrographs with even the highest powers as well or even much better than by ordinary sunlight.

Two reports have been presented to the surgeon-general; the first dated January 4, 1870, concerning the use of the magnesium and electric lights, the second, dated June 4, 1870, concerning the use of the lime light.

The electric light used in the first series of experiments was produced by 50 small Grove's elements, using a Duboscq's electric lamp. Not only could photographs be taken on as large a scale as by sunlight, but the exaggeration of light and shadow given by the electric light proved most admirably adapted to the production of clear and well-defined photo-micrographs. The magnesium light was found to possess many of the excellences of the electric light, but its best effect is given when the object is not magnified more than 1,000 diameters.

With the electric light the following method was used in the production of the photographs: —

The electric lamp was placed on a stool against the wall at one end of the room, and its light concentrated by a pair of condensing lenses on the lower lens of the achromatic condenser of the microscope. The microscope, a large Powell and Lealand's stand, was placed on a small table with levelling screws and arrangements for raising and lowering it at pleasure. The lenses employed were made by Wales, and specially constructed for bringing the actinic rays to a focus. For powers above the eighth-inch, the objectives of Powell and Lealand were found to answer an excellent purpose.

The electric light being arranged and working, the microscope was moved till the centre of the achromatic condenser and the centre of the illuminating pencil coincided; the object was then placed on the stage and adjusted. A cell of plate glass, filled with a saturated solution of ammonio-sulphate of copper, was placed between the light and the condenser, thus cutting off a large proportion of the luminous and calorific rays, besides making the colors of the object disappear, so that its appearance to the eye was the same that its photograph would have when taken.

The slide having been arranged, the eye-piece of the microscope was removed, and the image allowed to fall on the ground glass of the plate-holder, previously placed at the distance giving the required magnifying power. The objective once carefully focussed, the sensitive plate was exposed, thus finishing the difficult portion of the operation. An arrangement was used by which the objective could be focussed by the operator, when standing by the ground-glass plate.

Col. Woodward was thus able to produce from 12 to 30 negatives in an evening's work of 4 hours. About 30 seconds' exposure was found necessary for diatoms and Nobert's plate, when the object was magnified 1,000 diameters. In photographing soft tissues, it was necessary to place a plate of ground glass between the condenser and light to prevent interference-phenomena, which increased the time of exposure for this class of objects to about 3 minutes. Other powers were found to require proportional times.

The process employed with the magnesium light is essentially the same as with the electric light. As this light is composed of a mixed pencil with rays passing in all directions, there are no interference-phenomena caused by it; but the results with diatoms are inferior to those by the electric light for the same reason. An ordinary two-ribbon magnesium lamp was used, and a magic-lantern condenser served to condense the light in the achromatic condenser of the microscope. The ammonio-sulphate cell was used as with the electric light. An exposure of about 3 minutes was required to produce negatives of tissue preparations with 500 diameters.

Dr. Woodward says further, "In commenting on the above processes it may be remarked that for the anatomist and physiological investigator the magnesium lamp affords a satisfactory and sufficient source of light for the photography of normal and pathological tissue preparations. The same end can be equally well or even better obtained with the electric lamp, with which also the most difficult test-objects can be satisfactorily reproduced. Where economy of apparatus is the object, the magnesium lamp will be preferred by ordinary workers; but where much work is to be done, the high price of the magnesium ribbon more than counterbalances the cheapness of the apparatus, and the electrical light becomes the most economical. For the information of any practical photographers, who may be employed for work of this character, I may add the following remarks on the chemical process employed in the production of the negatives from which the appended prints were made. An ammonium and potassium portrait collodion, rich in alcohol, was employed, developed with the ordinary solution of iron, and fixed with cyanide of potassium. Where it was necessary to intensify, the hydro-sulphuret of ammonium was resorted to."

Dr. W. appends to his report 3 prints from negatives of a "Diatom Type Plate," taken, with a Wales' inch and a half, intended to illustrate the relative excellences of sunlight, the light of the magnesium lamp and that of the electric lamp. The first with sunlight is magnified 40 diameters, the second taken with the magnesium light, 48 diameters, the third by the electric light, 66 diameters. "It will be understood at once that, on account of the increase of distance, the second picture would have been slightly less sharp than the first, and the third than the second, had precisely the same source of light been employed; nevertheless, in spite of this disadvantage, to which they were purposely exposed, the magnesium and electric pictures are far superior to that taken by sunlight, and of the two the electric is the best. It is especially to be observed that in the electric picture the contrast obtained is so great that the objects appear clearly defined on an almost perfectly white ground, which is never the case with photo-micrographs taken with the sun as a source of illumination."

The second report concerns the use of the lime-light for photo-micrographic purposes. Pictures have been successfully taken with powers as high as 1,000 diameters. The practicability of the use of this light is important, because of its cheapness, its greater steadiness, and the little trouble given in its management. In his experiments Col. W. made the hydrogen as he consumed it, and sometimes made the oxygen in the ordinary manner, sometimes purchased it compressed in iron cylinders. The lamp used was a large magic-lantern burner. The magnifying lenses being removed, a cone of light proceeding from the condenser of the lantern was allowed to fall upon the achromatic condenser of the microscope as with the magnesium lamp in the earlier series of experiments. The ammonio-sulphate cell was used, but the ground glass required with the electric light was unnecessary.

The time of exposure required was much the same as with the magnesium lamp, and the pictures are equally good, for though the actinic power of the naked lime light is less than that of the magnesium light, the question of steadiness, involving the possibility of great concentration, plays a very important part.

The lime light had never before been successfully employed thus in this country, though some successful attempts were made several years ago in England, by a less perfect process than the one used by Col. Woodward. Experiments have been made in England by Messrs. Maddox, Abercrombie, and Wilson on the use of the magnesium light, but no results were obtained comparable with those described in the report.

Besides photographs of the sixth square of a Möller's Diatom Plate by solar, electric, magnesium, and calcium light, Col. W. presents several other photo-micrographs illustrating the perfection of the process. Photographed by the magnesium light the diatom *Arachinoidiscus Ehrenbergii*, magnified 400 diameters by a Wales' one-eighth objective, shows the elegant radiation and form of the dots with perfect clearness. A second example by this light is a nitrate-of-silver injection of a small vein and capillaries in the muscular coating of the urinary bladder of the frog, also magnified 400 diameters. Four photo-micrographs of diatoms by the electric light, magnified from 340 to 2500 diameters, show the markings very finely, as does also the admirable photograph of *Navicula lyra* taken by the lime light. Interesting as showing the perfect success attained in the original design of the experiments are photographs of an epithelial cancer of the larynx, magnified 400 diameters by Wales' one-eighth, and of human red blood-corpuscles magnified 400 diameters by a Powell and Lealand's one-sixteenth immersion objective.

COLOR-BLINDNESS.

Mr. Monck, of Trinity College, Dublin, propounds a new and interesting theory of color-blindness. The ordinary explanation is, that the eye is not sensitive to certain colors, to which it is objected that a color-blind person sees the whole spectrum, and that were this explanation true, there should not be color-blindness to complementary colors, red and green for example. Mr. M. bases his theory on the phenomena of accidental colors. If the eye be very sensitive to the excitation of the complementary tint, then this latter, appearing with vividness while we are gazing upon the original color, is so combined with it as to give rise to the grayish tint with which color-blind persons so often confound colors. The brighter the light, the more quickly and vividly would the accidental color be produced, which explains the fact that so many Daltonians see better in twilight. Another argument is, that color-blind persons rarely see accidental colors. According to this theory, then, the color-blind eye is one in which the complementary color is seen very rapidly and very vividly while looking at the primary color. If this view be correct the Daltonian will gain the best idea of a color by a transient glance at it, and in faint light.

OPTICAL PROPERTIES OF BENZILE.

A paper was read before the Academy of Science (Paris), by M. Des Cloiseaux, "On the Optical Properties of Benzile and of some Bodies of the Camphor Family, in the Crystallized State, and in Solution." The author found that crystals of benzile rotate the plane of crystallization in different ways, and the right and left crystals, when dissolved and crystallized two or three times, likewise give a mixture of crystals with opposite rotations. Solution of benzile in ether has no action or polarized light. Camphor of patchouli and mint camphor (menthole), both belonging to the hexagonal system, have a negative, uniaxial double refraction, and their solutions in alcohol deviate the plane of polarization to the left. Three camphors belonging to the cubic system, namely, Bornean camphor, terecamphine, and monohydrochlorate of turpentine, have no action on polarized light when crystallized, but in solution strongly deviate the plane of polarization to the right, the other two to the left.

FIZEAU'S EXPERIMENTS ON "NEWTON'S RINGS."

A comparison of the values of the wave-lengths of the light of the two principal *components* of the D line of the solar spectrum, as given by Angström, with some observations made some years since by Fizeau, shows a remarkable coincidence of results obtained by different methods, and is a new confirmation of the truth of the undulatory theory of light.

Fizeau produced the phenomenon of Newton's Rings by laying a convex lens of very long focus upon a piece of glass with plane parallel surfaces, and illuminating the combination by the monochromatic light of the soda flame. The lens was so arranged that it could be left to touch the glass or could be separated from it by a known distance, measured by a micrometer screw. On separating the lens from the glass plate, the rings were seen to move in towards the centre of the lens, where they successively disappeared, while their place was supplied by fresh rings which made their appearance at the circumference of the lens. Fizeau found that when the phenomenon was observed with sufficient care nearly 500 rings could be counted, flowing inwards one after another, but that after about this number the rings ceased to be visible, the surface of the glass showing a nearly uniform illumination all over, instead of a sharply defined alternation of light and dark bands. When, however, the distance between the lens and the glass plate was further increased, the rings reappeared, getting gradually more and more distinct, until when nearly another 500 had passed they had become as sharp as at first; but a still further increase of distance caused them again to become confused, and they ceased a second time to be discernible at about the fifteen-hundredth. With a still greater separation of the glasses, however, they reappeared again, and became quite sharp at the two-thousandth, after which, for a third time, they got gradually confused, and became indistinguishable at about the twenty-five-hundredth. So the phenomenon went on as the glasses were separated, and not until *fifty-two* such groups had been counted did the bands finally cease to be distinguishable. The two glasses were then separated by an interval of *fifteen* millimeters, or more than half an inch.

This remarkable phenomenon of the alternate periods of distinctness and confusion of the rings is easily explained, as M. Fizeau points out, when we remember that the light employed was not strictly homogeneous, but consisted of two portions of nearly but not quite equal degrees of refrangibility. If either of these two constituent parts of the light had been used by itself, it would have produced a set of rings, but the rings of one set would have been a very little larger than the corresponding rings of the other. Hence, if the two sets of rings are put together (as they were in Fizeau's experiments), they will nearly but not quite fit each other. If we examine a few rings at the centre, when the two glasses are in contact, they will appear to coincide precisely; but if they are traced to a sufficient distance from the centre the coincidence is seen not to be exact. For although the *twentieth* (say) of one set is not perceptibly bigger than the twentieth ring of the other set, the *five-hundredth* of one set is perceptibly bigger than the five-hundredth of the other, and when put upon it falls *almost exactly* half way between the five-hundredth and five-hundred-and-first of this set. Consequently, at about this part of the phenomenon, the bright spaces of one set of rings will occupy the same position as the dark spaces of the other set, and they will mutually obliterate each other. But since the *thousandth* ring of one set is nearly the same size as the thousand-and-first of the other, the two sets of rings will appear to fit each other again about this point; the *fifteen-hundredth* of the first set, however, is larger than the fifteen-hundredth-and-first of the second set, but not so large as the fifteen-hundred-and-second, and hence, at about the position of the ring, the rings of the two sets will overlap each other, and mutually efface each other's outlines. And, carrying such considerations further, it is evident that the apparent coincidence and overlapping of the two systems of rings would occur alternately at regular intervals.

In order to simplify this explanation, we have tacitly assumed the lens to be so large that several thousand rings could be seen between its centre and its circumference. Practically, this would be impossible; but by gradually separating the lens from the plane glass, we can, as it were, draw in towards the middle the rings which, with a larger lens, would be formed at a great distance from the centre.

Now, according to the explanation which the undulatory theory gives of the foundation of "Newton's Rings," the distance by which the interval between the glasses must be increased, in order that a given ring may come into the position previously occupied by the next smaller ring, must be equal to half the wave-length of the kind of light used for the experiment; and the distance of 0.28945 millimetres which, as M. Fizeau found by actual measurement, it was necessary to vary the space between the glasses, in order to make the rings go through one of the recurrent periods above described, that is to say, pass from sharpness to confusion and become sharp again, must contain just one more half wave-length of one portion of the light by which the rings are formed, than it does of the other.

This brings us to the point of contact between M. Fizeau's observations and those of Prof. Angström, to which we referred at the beginning. According to the latter, the wave-lengths of the two principal constituents of the light emitted by a flame containing the vapor of sodium (such as the flame employed by M. Fizeau) are respectively

0.000589513 millimetres.
0.000588912 "

Now, if we divide 0.28945 by half the former of these numbers, we get, as the quotient, 982; and if we divide it by half the second, we get, as the quotient, 983. That is to say, we find precisely as the undulatory theory requires, that the distance measured by M. Fizeau contains exactly one more half wave-length of the more refrangible constituent of the light of a sodium-flame than it does of the less refrangible part. And, moreover, if we calculate from Angström's determination of the wave-lengths, the number of rings which must intervene between the positions of greatest confusion and greatest distinctness, we find 491 of the one set and 491½ of the other, which agrees entirely with M. Fizeau's estimated round number of 500.—*Nature.*

ELECTRICAL DISCHARGE.

Prof. Von Bezold, in the "Philosophical Magazine," thus sums up the results of a series of experiments upon the electrical discharge:—

"1. When an electrical discharge, after traversing a spark-interval, is offered two paths to the earth (a short one and a long one interrupted by a test-plate), with small striking distances, the discharge is divided. With greater distances the electricity takes only the shorter path, and even carries with it electricity of the same kind from the other branch.

"2. If electrical waves be sent into a wire insulated at the end, they will be reflected at that end. The phenomena which accompany this process in alternating discharges appear to owe their origin to the interference of the entering and reflected waves.

"3. An electrical discharge travels with equal rapidity in wires of equal length, without reference to the materials of which these wires are made."

NEW GALVANIC BATTERY.

A new and important galvanic battery, invented by Bunsen, is described in Prof. Roscoe's address before the British Association. Only one liquid, a mixture of sulphuric and chromic acids, is employed, so that no porous cells are needed. The plates of zinc and carbon can all be lowered at once into the liquid and raised again at will. The electro-motive force of this battery is to that of Grove (the most powerful of all known forms) as 18 to 25; it evolves no fumes in working, and can be used for a very considerable length of time without serious diminution of the strength of the current, so that Bunsen writes that no one who has once used the new battery will think of again employing the old forms.

RESISTANCE PYROMETER.

Mr. C. W. Siemens has invented an instrument called an "Electrical Resistance Pyrometer," which will measure the heat of the hottest furnace. It is based on the principle that the resistance of pure metals to the electric current increases with the temperature in a very simple ratio. A platinum wire of known resistance is coiled round a cylinder of fine clay, and covered with a tube of the same material. The coil is connected with a Daniell's battery of 2 cells and with a resistance measurer, and placed in the furnace whose temperature we wish to ascertain. It is then only necessary to read off the indications of temperature on the graduated resistance measurer.

EXPERIMENTS ON THE ATLANTIC TELEGRAPH CABLES.

The report of the Coast Survey Expedition of 1866, regarding electrical measurements made on the cables of 1865 and 1866, has been published in the Smithsonian "Contributions." The following is a summary of Dr. Gould's conclusions taken from the "Journal of the Franklin Institute:"—

Four leading questions were to be answered by the experiments. 1. The character of the agency which gives the telegraphic signal upon the closing or interruption of the galvanic circuit, and the route by which its transmission is effected.

2. The influence exerted upon the conductor by using the earth as part of the circuit, or by placing the complete circuit in electrical communication with the earth.

3. The extent to which the velocity of propagation of the signals is dependent upon the intensity of the electromotive force, and upon the resistance of the conductor.

4. The equality or difference in speed of the signals from the positive and from the negative electrode, when the other is connected with the earth; as also the relative velocity of signals given by completing and by interrupting the circuit.

The length of the cable of 1865 is 2,186 statute miles, and that of the cable of 1866 is 2,134 statute miles. Each conductor is constructed of 6 copper wires twisted round a seventh one, and has a diameter of one hundred and forty-seven one thousandth inches. The conducting power of the wire is 93.1 for the cable of 1865, and 94.6 for that of 1866, the conducting power of pure copper being 100. The cable of 1865 gave a resistance of 4.01 ohms per knot, the "insulation" or resistance of the coating being 2,945 megohms per knot, and the electrostatic capacity 0.3535 farad to the knot. That of 1866 gave a resistance of 3.89 ohms per knot, and an insulation of 2,437 megohms, the electrostatic capacity being the same as in the cable of 1865. The total resistance to conduction in the first cable is, then, about 7,650 ohms, the total resistance of the insulator 1,505,000 ohms, and the total electrostatic capacity about 670.4 farads. In the second cable, the total resistance is about 7,270 ohms, the total insulation 1,316,000 ohms, and the total electrostatic capacity 654.5 farads.

The battery employed by the telegraph company was Minotti's, a modified form of Daniell's. Mr. Farmer estimates that after the full strength of the current is developed, one cell should give upon one cable with earth-connection about 110 farads per second.

Several series of experiments were made with varying battery power, and different arrangements of the connections, in some using the earth circuit, in others not using it, sending both positive and negative signals.

The first question to be investigated is, whether the positive and negative signals were transmitted with the same velocity. A comparison of the records of the same signals at the two stations decides this, without the necessity of knowing the absolute time of transmission. This comparison gives us the interval $T - T''$ (the difference of the time indicated at the same moment by the two clocks, diminished by the time of transmission in the case of signals given from Valencia, and increased by this amount for signals from Newfoundland). Any excess of the time consumed in the passage of either class of signals should manifest itself by a superior value in the measures of the temporary clock-difference derived from that class when the signals are sent westwardly. For earthward signals the reverse holds. An examination of the recorded results shows that the positive and negative signals travel with the same velocity under the same circumstances.

The speed of the two kinds of signals being thus taken as the same under similar circumstances, the time required for their transmission is easily deduced, being one-half the difference between the measures of longitude as derived from the records at the respective stations. The weak point in the observations is the absence of any automatic record of signals received, but it is probable that the aggregate personal error of the two observers is very close to 0.606^s, which value is adopted in the investigation.

The experiments of November 5th and 6th were conducted without the use of any earth circuit. Each station sent signals with a battery of 3 Minotti's cells, receiving them with its battery disconnected. The mean interval consumed in the transmission of the signals appears to have been 0.29^s on the former, and 0.26^s on the latter occasion.

With a battery of 3 Minotti's cells, the maximum permanent current would not exceed 168 farads in the joined cables, and to develop nine-tenths of this current more than 1¼ second would be needed. With 3 Daniell's cells the maximum current would not exceed 185 farads. Assuredly, we cannot suppose that in the lapse of three-tenths of a second, when not more than one-seventh of this current had been developed at the farther station, this battery would have charged the 2 joined cables, each of which possessed an electrostatic capacity of more than 650 farads. Hence the impulse on which the transmission of the signal depends must have been propagated along the conductor by some other means than by charging its successive parts electrically, that is, fully and in the ordinary sense of this expression. The 30 farads, more or less, which could have been generated before the signal arrived at the distant extremity of the cables, would have been consumed in charging the first six or seven hundredths of the conductor.

Messages were effectually and distinctively transmitted in each direction, by the use of an electromotor formed by a small percussion cap containing moistened sand, upon which rested a particle of zinc. The current here evolved could scarcely have amounted to more than 6 or 7 farads, so that nearly 2 minutes would have been requisite for charging a cable, yet the transmission time was certainly very small, although it was not definitely measured.

The experiments of November 8th and 9th differed from those of the 5th and 6th only in that the Newfoundland battery consisted of 10 cells instead of the same number as was employed at

Valencia. The mean times of transmission were 0.25^{s} and 0.24^{s}, indicating an increase of speed with an increase of electromotive power. And, so far as the experiments on these 4 days are concerned, we might infer that on the complete metallic circuit formed by the 2 cables, the time for transmitting the signals through about 3,475 kilometers, or 2,160 statute miles, was not far from 0.29^{s} for a battery of 3 cells, 0.26^{s} for one of 4 cells, and 0.215^{s} for one of 10 cells.

On the other hand, the average transmission time for signals sent by a current induced in a single cable by means of a "condenser," with a battery of 10 cells, was 0.31^{s} on the 25th, and 0.34^{s} on the 28th of October; the mean interval on these 2 days being 0.328^{s}. Each of the condensers used possessed an electrostatic capacity of about 20 farads; so that with a tension of 10 cells or 8.4 volts, their capacity would not be far from 168 farads, or equal to that of about 590 miles of cable, or, in other words, a little more than one-quarter the capacity of one whole cable.

Results of recorded signals give 0.26^{s} as the transmission time through one cable with earth return, when the ground connection was made with the zinc, and 0.27^{s} when it was made with the middle of the battery, the former corresponding to the use of 4 cells at one station only, the latter to 2 cells at each station.

The velocity of signals made by closing and interrupting the circuit is next considered, the conclusion being that in general a longer time was required for the transmission of signals after an interval of 10 seconds than after an interval of 5 seconds. In those cases where no earth-connection existed, and the signals were alternately positive and negative, the cable was meanwhile assuming its electrical equilibrium, so that a positive signal was transmitted more rapidly through the conductor when it was affected with a larger amount of negative electricity, and a negative signal more rapidly through a conductor containing more positive electricity. This affords new testimony to the erroneous character of the supposition that the conductor must be charged through any portion of its length, in order to transmit a signal beyond that portion.

As showing the continued existence of currents (doubtless engaged in establishing equilibrium) during the intervals between the signals, it may be of interest to mention that on one occasion when the 2 cables had been joined at Heart's Content, without battery, and while the Valencia battery had been temporarily disconnected, signals from Newfoundland were distinctly received. They were weak, and the deflections of the needle were scarcely one-fifth as large as usual, yet they were none the less distinct, and a complete set of signals, 10 in number, at proper intervals, and preceded by a "rattle," was recognized at Valencia. No other record of them was made, than the fact of their transmission by alteration of the make-circuit and break-circuit signals, although no battery had been connected with the cable for several minutes.

A series of experiments was made for the purpose of ascertaining the effect of changes in the electro-motive force upon the speed of the signals, and whether these signals could by the interpolation of any resistance between them and the galvanometer be made to traverse the double length of the cable before reaching the galvanometer at the same station.

The construction of the signal-key used in these experiments was such that only about one-seventieth of a second was occupied in pressing down the button. All signals by which currents were sent were given in this way, but the break-circuit signals were given by removing the thumb from the button, which was then lifted by the tension of the spring. This tension being less than the muscular force of the thumb when the button was pressed down, a longer time was consumed in traversing the distance between the stops, and for this repeated experiments give 0.035^s as a near approximation to the average interval. Now, since the ordinary signals record themselves upon the chronograph when the arm carrying the button leaves one stop, but are not really given until it reaches the other, all the recorded intervals between the instants of giving and receiving make-circuit signals will be too large by about one-seventieth of a second, or approximately 0.015^s; while for break-circuit signals the reverse obtains, and the recorded interval will be too small by about 0.035^s. Consequently, in comparisons between break-circuit signals and others, a correction must be applied, varying with the temporary adjustment of the signal-key, but amounting on the average at Valencia to not far from 0.05^s. This correction must be borne in mind in drawing inferences as to the relative velocity of break-circuit and make-circuit currents. Dr. Gould does not apply it in his tables, however, because no measurements were made to determine the pass-time for the Newfoundland key.

In these experiments the circuit was formed of the two cables with no other connections than the same key, galvanometer, and battery at Valencia which had been employed for the other work of the expedition.

Exp. I. 4 cells. Circuit made and broken. Key between Zincode and galvanometer.

	No.	Mean Interval.
Make circuits,	11	0.257^s
Break circuits,	11	0.229

Exp. II. 4 cells. The same with 126 ohms' resistance between key and galvanometer.

Make circuits,	10	0.279
Break circuits,	9	0.227

Exp. III. 4 cells. Key and galvanometer upon opposite sides of the battery.

Make circuits,	13	0.278
Break circuits,	14	0.225

Exp. IV. 4 cells. The same with 126 ohms' resistance between key and cable.

Make circuits,	11	0.278
Break circuits,	11	0.220

Exp. V. 1 cell. Positive and negative signals.

Positive.		Negative.		Both.	
No.	Mean.	No.	Mean.	No.	Mean.
2	0.240	8	0.292	10	0.282

Exp. VI. 2 cells. Positive and negative signals.

10	0.249	9	0.242	19	0.246

Positive.		Negative.		Both.	
No.	Mean.	No.	Mean.	No.	Mean.
Exp. VII. 4 cells. Same.					
8	0.268	10	0.290	18	0.279
Exp. VIII. 10 cells. Same.					
10	0.270	10	0.245	20	0.258
Exp. IX. 10 cells. Resistance of 25 ohms interposed between key and galvanometer.					
10	0.254	10	0.258	20	0.256
Exp. X. 10 cells. Resistance increased to 251 ohms.					
9	0.287	10	0.289	19	0.288
Exp. XI. 10 cells. Resistance increased to 2513 ohms.					
10	0.305	9	0.286	19	0.296
Exp. XII. 10 cells. Resistance increased to 25,130 ohms.					
11	0.288	10	0.299	21	0.293

From these experiments it may fairly be concluded: —

1. That there was no real difference in the interval for the make-circuit and break-circuit signals. The mean from the first 4 experiments gives after application of the corrections for pass-time of the key, an interval 0.261^{s} for the make circuits, and 0.260^{s} for the break circuits.

2. That the relative positions of key, galvanometer, and battery exerted no perceptible influence upon the result when a battery of 4 cells was employed. The mean intervals from the first 2 and from the second 2 experiments are 0.258^{s} and $0,262^{s}$ respectively.

3. That no appreciable effect was produced by the interpolation of 126 ohms' resistance. The mean intervals, with and without this resistance, were 0.258^{s} and 0.263^{s}.

4. That no marked diminution of the interval was produced by an increase of the battery from 2 to 10 cells. The results with 1 cell, although untrustworthy, indicate a somewhat less interval. The others vary by less than their probable errors, yet the interval was certainly not less with 2 cells than with 10.

5. From the last 3 experiments it would appear that the interval was slightly longer after resistances above 250 ohms had been introduced. Yet it was no longer in the twelfth experiment when the resistance between the key and galvanometer was more than two-thirds greater than the whole resistance of the 2 joined cables, than in the eleventh, when it was only one-sixth as great as that of the 2 cables.

6. We have every reason for believing that in all these 12 experiments the measures of the intervals were merely determinations of my own personal equation in noting signals, which, as has been shown in Chapter IX., had been found by special investigation to be about 0.275^{s}. The variations from this value amount in but few cases to more than 0.03^{s}, which we have seen to be the normal range.

7. These experiments are entirely confirmatory of what would have been anticipated from theory, namely, that a signal given by closing a galvanic circuit is transmitted in both directions simultaneously, and with equal velocity under similar circumstances; so that under no ordinary practicable circumstances

could a signal from either station fail to traverse both parts of the circuit at that station before passing on to the other.

Since my former investigation (Proc. Amer. Assoc. Adv. Sci., 1850, p. 71; Am. Jour. Sci. xi., 67, 154) the progress of science has thrown light upon many points which were then subjects of doubt or of individual opinion. The condition of an open galvanic circuit is now almost universally conceded not to be essentially different from that of an interrupted conductor to an electrical machine. The velocity of a current is also known to be dependent upon its quantity, and therefore generally upon its intensity, as well as upon the resistance of the conductor. But it appears questionable whether the law is as simple as has been supposed by some, who have regarded the velocity as inversely proportional to the capacity of the conductor multiplied by its resistance, and, therefore, in a homogeneous conductor to the square of the length. For the problem, as it now presents itself, does not pertain so much to the time for transmission of a given signal, as to the time for its transmission with a certain force, depending on the sensitiveness of the receiving apparatus; since the electrical impulse or disturbance consists of a continuous series of molecular influences which propagate themselves in every possible direction according to the inverse ratio of their several resistances. And the form of the conductor, as well as other conditions, may essentially modify the time requisite for the attainment of the prescribed force at the other extremity of the line. A current may thus be temporarily established in part of an open circuit, continuing until the battery and conductors have attained an electrostatic equilibrium. The time required for attaining this equilibrium depends of course simply on the capacity and form of the conductors, and on the energy of the battery; but the first electrical impulse may reach the most remote point of the circuit before a portion nearest the battery has received its full charge. Similarly, in a closed circuit, the distant extremity of the line may well be supposed to perceive some slight electrical disturbance from a signal before its full force is manifested at intermediate points, so that a signal might be received with a delicate galvanometer at the farther extremity, before it could be recognized upon an electro-magnet at half the distance. And this, too, apart from any consideration of increasing intensity in the electromotor.

The circuit formed by the two cables might, although broken at Valencia, thus serve to establish what would practically be a momentary current at Newfoundland when the battery at that station was introduced, deflecting the galvanometer there for an instant, and the change of statical condition in the cables at Valencia would thereupon be manifest to the electroscope. But the closure of circuit at Valencia would be accompanied by instantaneous deflection of the galvanometer, with corresponding insensibility of the electroscope. Thus a signal given by closing or interrupting an insulated circuit at any point is instantaneously transmitted from that point in both directions and at full speed; *but the interval* before it attains its total force at any other point must depend upon the character of the intervening conductor. The question as to the route by which signals are transmitted when part of the circuit is formed by the earth, is thus disposed of; and the position maintained in the memoir above cited is entirely corroborated, although it loses its theoretical significance.

The duration of one signal current was intended to be uniformly one-quarter of a second, but depended upon the skill and care of the observer, no automatic signal-giver having been employed. Every electrician knows how greatly the strength of the current is augmented by an increase of its duration from 0.2^s to 0.3^s, yet the duration of the signals varied frequently through a larger range than this. Still the actual length of each signal as recorded upon the chronograph register, and its average did not vary much from the prescribed duration of 0.25^s.

It appears manifest that not an electrical charge or discharge, but simply an electrical disturbance, is requisite for transmitting a signal; that an inductive impulse, sufficient to deflect the galvanometers employed, was transmitted through 1 cable, having at each end a condenser with 10 cells, in somewhat less than the third of a second, 5 seconds after the transmission of an impulse of the opposite sort; that with a circuit formed by the 2 cables, a smaller electromotive force sufficed to transmit the signals with yet greater rapidity; that the signals travelled more rapidly through a cable which had not recovered its electrical equilibrium after a current of the opposite character; and that the speed of the signals is modified by the earth connections more rapidly than by changes in the battery power. And the very marked differences found in the rates of transmission, between signals given by completing an interrupted circuit and those given by interrupting a closed circuit, may perhaps lead to investigations which will afford an explanation.

CHEMISTRY.

ANTOZONE.

In the first series of Dr. Meissner's researches upon oxygen he arrived at the remarkable conclusion that oxygen under the influence of electrical tension was converted not only into ozone, but also into another modification, which always appeared simultaneously, and which formed, when brought into contact with watery vapor, especially after the absorption of the ozone, a peculiar dense mist. This second modification of oxygen Meissner identified with Schönbein's antozone. So remarkable were these results, and so important their bearing, if true, not only upon our theories of ozone itself, but also upon the philosophy of chemistry, that Meissner desired to repeat his experiments, studying particularly the character of the antozone-mist and the effects of electrical tension upon the volume of the oxygen submitted to the discharge. The results of these experiments constitute a paper published the last year by Dr. Meissner.*

Oxygen is submitted to the action of electricity in a Siemen's or Von Babo's apparatus, is then passed into a receiver containing a concentrated solution of iodide of potassium in which the ozone is completely absorbed, and finally through water contained in a second receiver; the gas, as it issues from the water, forms above it a thick white mist, which also appears in a less degree over the solution of iodide of potassium, but which is denser the less concentrated the solution and the more favorable the ozonizing conditions. To prove that this mist consists solely of electrized oxygen and water, Meissner proves experimentally, to his own satisfaction: 1st. That no other gas but oxygen is in any way concerned in the production of the phenomenon, particularly no nitrogen, chlorine, hydrogen, or carbonic acid; 2d. That for the production of the result the presence of aqueous vapor in the electrizing tube is not necessary; 3d. That the solution of iodide of potassium used for the absorption of the ozone has nothing whatever to do with the appearance of the phenomenon, further than is implied in effecting the removal of the ozone from the current of electrized oxygen.

---

* Neue Untersuchungen über den elektrisirten Sauerstoff.—Abhandlungen *der K. Gesellschaft* der Wissenschaften zu Göttingen, XIV. (1869).

In regard to the first and second points, after detailing the very carefully conducted experiments which were performed, Meissner believes, "that these experiments, not once only or a few times repeated, but performed very frequently, prove the following point: that the mist formed by deozonized electrized oxygen with aqueous vapor appears when neither chlorine, nitrogen, ammonia, hydrogen, carbonic acid, nor watery vapor is present in the tube where the electrizing occurs; and that the presence or aid of neither of these substances is necessary for its subsequent formation; that, in other words, the mist phenomenon requires only dry electrized oxygen, the iodide of potassium used for deozonization and the vapor of water for its production." The third point is proved by the substitution for the iodide of potassium of a variety of other bodies, differing widely in chemical character and agreeing only in the property of absorbing ozone. The mist is chemically identical whatever be the agent used to absorb the ozone; it is neither acid nor alkaline, consists of a body neither soluble nor insoluble in water, but is solely a mechanical or adhesive combination of oxygen and water, which, when washed and collected in a gas-holder, gradually disappears, fine fluid drops collecting upon the walls of the vessel, which, when examined, are found to be pure water, containing possibly, under certain conditions, a trace of peroxide of hydrogen. Experiment leads to the conclusion that there exists in the pure, dry electrized oxygen, besides unaltered oxygen and ozone, a third body, a third modification or condition of oxygen, to which the phenomenon of the mist is to be ascribed. The paper further treats of the action of various substances on electrized oxygen, and in a second section discusses the "quantitative estimation of ozone and the contraction of volume in electrizing oxygen." — *From an "Abstract of the second series of Professor Meissner's Researches upon Electrized Oxygen," by Prof. Barker in the Amer. Jour. Science,* L. (1870), *pp.* 213–223.

HYDROGENIUM-AMALGAM.

"When zinc-amalgam is shaken with water a slow decomposition of the latter takes place, recognized by the formation of flocculi of hydrated oxide of zinc, and the evolution of small bubbles of hydrogen on allowing the mixture to stand for a time. This decomposition of water by zinc is intensified when a small quantity of bichloride of platinum is present; a spongy body then being formed on the surface of the zinc-amalgam. This body I have found to be an alloy of hydrogenium and mercury.

"In order to obtain the hydrogenium-amalgam on a larger scale, zinc-amalgam, containing a few per cent. of zinc, is shaken thoroughly with about an equal volume of bichloride of platinum, containing about 10 per cent. of the bichloride, care being taken to keep the mixture cool. The zinc-amalgam swells up considerably, precisely as in the ammonium-amalgam experiment, and continues to evolve hydrogen till the decomposition of the amalgam is *complete.* I found that the volume of the hydrogen thus developed was, in several experiments, from 100 to 150 times that of the mercury employed. This hydrogen possesses a faint odor.

"When this amalgam of hydrogenium is pressed, directly after its preparation, between sheets of filtering paper, and then spread out in a layer to the air, the temperature soon rises considerably, and vapors of water are formed, which may be condensed in a glass receiver. The finely divided platinum present is obviously the cause of this rapid oxidation of the hydrogenium. In this action of bichloride of platinum upon zinc-amalgam oxychloride of zinc is at the same time formed; and though this may be removed by means of chlorhydric acid, yet by this treatment a part of the hydrogenium-amalgam is destroyed. If after this it be washed with water, it undergoes a very slow decomposition, the volume increases, and bubbles of hydrogen escape through the water above.

"Platinum, after perfect amalgamation, does not act as energetically as in its nascent state; that is, when precipitated on the amalgam. When platinum-amalgam is mixed with zinc-amalgam the decomposition of the water by the zinc is extremely slow, and the hydrogenium-amalgam does not appear for some time. Under certain conditions, moreover, the hydrogenium-amalgam is formed without the aid of the bichloride of platinum. I had at one time about 20 pounds of mercury containing zinc, which was left standing in a bottle with water for 3 weeks; the hydrogenium-amalgam formed on the surface of the mercury, gradually decomposing above and being renewed from below."—*O. Loew.* — *Annals Lyceum Natural History of New York.*

AMMONIUM–AMALGAM.

The existence of ammonium NH_4, as such, in what is known as ammonium-amalgam, has never been demonstrated, although its constituents escape in proper proportions from the amalgam. If the hydrogen escaping from the amalgam, together with the ammonia (NH_3), be shown to be in the nascent state, it would be evidence that it had just been in chemical combination with the ammonia; in other words, that metallic ammonium existed in the amalgam. Some pellets of sodium were placed in contact with some particles of the transparent variety of phosphorus, wrapped in bibulous paper and plunged beneath the surface of water. A red glow was seen; and as the nascent hydrogen came in contact with the phosphorus, bubbles of phosphide of hydrogen were formed. Occasionally one would inflame as it came into contact with the atmosphere, placing the nature of the reaction beyond a doubt. As phosphide of hydrogen cannot be formed by direct synthesis if ordinary free hydrogen be employed, this becomes a test for the presence of that gas in its nascent state. The hydrogen escaping from the ammoniacal amalgam was now tested by this process. A sodium-amalgam, dipped beneath a solution of chloride of ammonium, was employed; and it became necessary to wait until the sodium was exhausted that results might not be vitiated by the nascent hydrogen escaping from the water. At the proper time the decomposing amalgam was covered with fragments of transparent phosphorus, when many bubbles of inflammable phosphide were obtained. The hydrogen must then have been in the nascent state and just escaping from the ammonium. — *Dr. Gallatin, in the Philosophical Magazine, July*, 1869, *p*. 57.

ACTION OF LIGHT ON CRYSTALLIZED SULPHUR.

We know, from the researches of Schroetter on the allotropic modifications of phosphorus, that ordinary phosphorus is converted by the action of light into the amorphous variety. M. Lallemand finds that a similar effect is produced on ordinary crystallized sulphur. He exposed a solution of sulphur in bisulphide of carbon, in a sealed glass vessel, to rays of light concentrated by a lens, and obtained a copious deposit of amorphous sulphur. On passing the emerging rays through a prism, he found that the luminous spectrum showed no rays between G and H, and that the ultra-violet rays had disappeared entirely. A solution of phosphorus in bisulphide of carbon acts similarly, although more slowly, and the spectrum produced by the emerging light shows a sensible diminution of intensity only in the neighborhood of H in the luminous spectrum, and only the most refrangible actinic rays have disappeared. — *Comptes Rendus*, LXX., *p*. 182.

SOLUBILITY OF SULPHATE OF LEAD IN ALCOHOLIC SALINE SOLUTIONS.

Very considerable quantities of sulphate of lead can be held dissolved in *water* by means of many acetates, citrates, tartrates, and by various other salts. Prof. Storer finds that a certain proportion of lead can be held dissolved in presence of sulphuric acid, even in an alcoholic solution like wine, by the action of various soluble alkaline salts capable of decomposing and of being decomposed by sulphate of lead. Attention was called to the fact by the analysis of a sample of sherry, which proved to contain some salt of lead, and, at the same time, free sulphuric acid. Among the salts which possess in dilute alcoholic solutions this power of holding lead dissolved, are the acetate, tartrate, succinate, citrate, and dicitrate of ammonium, and tricitrate of potassium. The experiments made show clearly that very considerable quantities of sulphate of lead can be held in solution by weak alcohol charged with various salts. It may, therefore, reasonably be inferred that wines sometimes retain lead in solution, in consequence of this action of the acids and salts peculiar to wine upon lead compounds ignorantly employed to correct acidity — *Proc. Amer. Acad.*, X., *p*. 59.

JARGONIUM.

In the last volume of this Annual, a statement was made of the fact that Mr. Sorby, in the course of an examination of the absorption-spectra given by zirconia and other earths, found that certain specimens of jargon from Ceylon yielded a spectrum of so marked a character as to lead to the supposition of the existence of a new element, to which he gave the name of jargonium. Upon analyzing the jargon a quantity of substance was obtained which, while resembling zirconia, was sufficiently distinct from it to warrant the supposition of its being the oxide of a new metal. At the same time the element uranium failed to reveal itself in the course of ordinary or spectral analysis. In February of the last year Mr. Sorby read a paper before the Royal Society * describing more recent experiments, which show that the absorption-bands which seemed to indicate the presence of a new element are really due to a mixture of the oxides of zirconium and uranium, and this reaction is so delicate as to give evidence of the presence of uranium when the amount is extremely small. He found that, in the case of transparent blowpipe beads of borax with microcosmic salt, it is requisite to have about as much as one-fiftieth grain of protoxide of uranium to show faintly the characteristic absorption-bands; whereas when present along with zirconia in crystalline beads, one-fifty-thousandth grain gives an equally well-marked spectrum, and one-two-thousandth grain shows it far better than a larger quantity, which makes the bead too opaque.

MANUFACTURE OF CHLORINE.

Weldon's Process.— In the last volume of the "Annual of Scientific Discovery" mention was made of the process invented by Walter Weldon, for the utilization of the chloride of manganese residues from the chlorine manufacture by the production from the same of a compound which he calls manganite of calcium, which is used again to generate chlorine. This process has been extensively adopted in England within the last year or two, and at the meeting of the British Association at Liverpool, 1870, the inventor of the process read a paper,† giving further details, and at the same time he exhibited a model of the apparatus employed.

The following is an abstract of this paper: The vessels comprised in this apparatus are arranged at 5 successive elevations, so that after having been pumped up to the highest of them the liquor operated upon can afterwards descend to all the others by its own gravity. The lowest of these vessels is a well, which is furnished with a mechanical agitator. The slightly acid chloride of manganese liquor with which the process commences runs from the stills in which it is produced into this well, and is there treated with finely divided carbonate of calcium, the action of which is facilitated by energetic agitation. When the neutralization of the free acid which is at first contained in this liquor, and the decomposition of the sesquichloride of iron and sesquichloride of aluminum, which are also at first contained in it, are completed, the liquor is pumped up into settling-tanks placed nearly at the top of the apparatus and known as the *chloride of manganese settlers*. It now consists of a quitė neutral mixed solution of chloride of manganese and chloride of calcium, containing in suspension considerable quantities of sulphate of calcium and small quantities of oxide of iron and alumina. These solid matters rapidly deposit in the chloride of manganese settlers, leaving the bulk of the liquor perfectly bright and clear and of a faint rose-color. The next step is to run off the clear portion of the contents of the chloride of manganese settlers into a vessel placed immediately below those settlers, and called the *oxidizer*. This is usually a cylindrical iron vessel, about 12 feet in diameter and about 22 feet deep. Two pipes go down nearly to the bottom of the oxidizer, — a large one for conveying a blast of air from a blowing-engine, and a smaller one for the injection of steam. The latter is for the purpose of raising the temperature of the contents of the oxidizer, when necessary, — for sometimes the chloride of manganese liquor reaches the oxidizer sufficiently hot, — to somewhere between 130° and 160° or 170° F. Immediately above the oxidizer is a reservoir containing milk of lime. The oxidizer having received a charge of clear liquor from the chloride of manganese settlers, and this liquor having been heated up to the proper point, if it was not already hot enough, blowing is begun, and milk of lime is then run into the oxidizer as rapidly as possible, until the filtrate from a sample taken at a tap placed nearly at the bottom of the oxidizer ceases to give a manganese reaction with solution of bleaching-powder. A certain further quantity of milk of lime is then added, and the blowing is continued until peroxidation ceases to advance. That point is usually attained when from about 80 to 85 per cent. of the manganese present has been converted into peroxide. The contents of the oxidizer are now a thin black mud, consisting of solution of chloride of calcium containing in suspension about 2 pounds of peroxide of manganese per cubic foot, these two pounds of peroxide of manganese being combined with varying quantities of protoxide of manganese and lime. This thin mud is now run off from the oxidizer into one of a range of settling tanks (*mud-settlers*) placed below it, and is there left at rest until about one-half of its volume has become clear. The clear part, consisting simply of a solution of chloride of calcium, is then decanted, and the remainder, containing about 4 pounds of peroxide of manganese per cubic foot, is then ready to be used in the stills. There it reacts upon chlorhydric acid, liberating chlorine, with reproduction of exactly such a residual solution as was commenced with. With that solution the round of operations is begun again; and so on, time after time, indefinitely.

---

* *Chem. News*, xxi., p. 73, American Reprint, vi., p. 193.

† *Printed in* the "Chem. News" for Sept. 23, 1870, Vol. xxii., p. 145.

In regard to the amount of lime necessary: The lime used is slaked with as nearly as possible an equivalent of water and passed through fine sieves. Including the portion which is sieved out, and which, although it does not go into the oxidizer, is usually charged to the process, the amount of lime used at present averages 14 cwt. per ton of bleaching-powder prepared. Until quite recently it was supposed that whatever proportion of lime was used in the oxidizer, products could not be obtained containing less than an equivalent of base (or bases) to every equivalent of peroxide of manganese. Now, however, products are regularly obtained containing only between 0.9 and 0.7 equivalent of base, and there have been obtained, occasionally, compounds containing as little as 0.5 equivalent of base; in case of producing regularly compounds containing only one-half an equivalent of base, the amount of lime required for this purpose may be reduced as low as 10 cwt. per ton of bleaching-powder, and already, at one work on the Tyne, the amount has been reduced to 12 cwt.

The mechanical power expended in the injection of the necessary amount of air into the oxidizer has hitherto averaged between 7 and 8 horse-power for 1 hour per 100 pounds MnO_2 made; but this amount can probably be diminished. Expressed in terms of the amount of bleaching-powder produced, it may be said that the production of 1 ton of bleaching-powder requires the expenditure of from 35 to 40 horse-power for 2 hours.

The quantity of acid consumed per ton of bleaching-powder made by means of manganite mud, varies with the degree of care with which the process is performed and with the general skill of the manufacturer, being in some cases considerably below the average quantity consumed in making a ton of bleaching-powder by means of native manganese, while in other cases it is scarcely at all below that quantity. To produce a ton of bleaching-powder by the ordinary process there is required the amount of acid obtained from not less than 60 cwt. of salt, and often there is used as much acid as would be produced from 80 cwt. of salt. By the new process at least one manufacturer, whose mud contains as yet by no means the minimum amount of base, consumes to the ton of bleaching-powder only 170 cubic feet of acid at 24° Twaddell, — a quantity which may be produced by less than 48 cwt. of salt.

The loss of manganese which occurs in this process at present varies from about 4 per cent. to about 10 per cent. The deposit of sulphate of calcium and other matters in the chloride of manganese settlers has to be removed as a thin mud, that is, mixed with a quantity of the solution of chloride of manganese. By suitable washing the amount of manganese lost may be reduced to 2 per cent., but it ordinarily averages 5 per cent. No other sources of loss exist, except it be from carelessness on the part of the workmen. Beyond the sulphate of lime and other bodies which are deposited in the chloride of manganese settlers, the only residual product of the process, and the only other thing which has to be thrown away, is the solution of chloride of calcium. As this solution represents all the lime and all the limestone used in the process, and two-thirds of the chlorine contained in the acid employed, attempts have been made still farther to improve the process by the substitution of magnesia in the place of lime, and by decomposing by heat the resulting chloride of magnesium into magnesia, for use over again, and chlorhydric acid. In this form, the process is capable of yielding all the chlorine contained in the acid employed, and apart from mechanical loss employs no materials except coal and air, which are not used over and over again. Experiments on a small scale promise well for the value of this modified process.

Deacon's Process. — If a mixture of chlorhydric acid and oxygen be sufficiently heated, portions of the hydrogen and oxygen combine, and chlorine is set free to a certain small amount. This proportion is very much increased by passing a heated mixture of these gases over certain substances which influence this reaction without being themselves, as far as appears, affected by it. Copper salts possess the power of bringing about this reaction in a very marked degree, sulphate of copper being most conveniently employed. All the compounds of lead, with the exception of the sulphate, act in the same way, although requiring a higher temperature. All the manganese compounds act similarly, but the temperature required is so elevated that all the liberated chlorine is not obtained as such, a certain amount apparently recombining with a portion of the hydrogen of the water formed.

It is proposed to make use of these facts in the commercial production of chlorine, by passing the mixed gases over common bricks soaked in a saturated solution of sulphate of copper, and then dried. It has been found that the chlorhydric acid, as evolved from the ordinary salt-cake apparatus, contains, mixed with it, a sufficient quantity of air for the reaction to take place. It has been found that iron resists very completely the action of chlorine in the decomposing apparatus. A common iron gas-pipe, exposed to the heated chlorine for several months, shows no appreciable wear. The chlorine produced is mixed with a large proportion of nitrogen, but no difficulty is anticipated in the making of bleaching-powder, if the saturation is brought about systematically by allowing the strong gases to meet lime nearly saturated, and then passing the weaker gases over fresh lime. Any undecomposed chlorhydric acid is removed by passing the gases through water, the dilute acid formed dissolving only mere traces of chlorine. — *Abstract of a paper read before the British Association,* 1870, *by Henry Deacon.*

Hargreaves' Process. — Mr. James Hargreave, of Widness, has devised a method for producing chlorine without the use of oxide of manganese. He has a process for the separation of phosphorus from the iron slag produced in the puddling operation of the iron manufacture. In carrying out this process the iron slag is treated with chlorhydric acid, and thereby protochloride of iron in solution is obtained as a by-product. This solution is evaporated to dryness, and the dry protochloride, by slow application of heat with access of atmospheric air, becomes perchloride, which undergoes decomposition, yielding chlorine and peroxide of iron. This process yields an equivalent of chlorine for each equivalent of chlorhydric acid employed.

ALKALI MANUFACTURE IN GREAT BRITAIN.

In 1861, it was estimated that the total quantity of salt decomposed in Great Britain, for the production of soda, was 260,000 tons. According to the returns of the Alkali Manufacturers' Association for the year 1869, the total quantity decomposed was 326,000 tons, showing an increase of 25 per cent.

CLAUDET'S PROCESS FOR THE EXTRACTION OF SILVER.

The amount of pyrites annually burned in Great Britain in the manufacture of sulphuric acid reaches 350,000 tons, of which at least 250,000 tons contain a sufficient amount of copper to render its treatment for that metal commercially advantageous. For several years past a large proportion of the "burnt ore" produced in the various chemical works of the country has been worked by what is known as the *wet process* of extraction. By the process of liquid extraction at present usually employed, the burnt ore is first finely ground and sifted, and subsequently roasted with common salt until by the oxidation of the metallic sulphides present a portion of the alkaline salt is converted into sulphate of sodium, whilst the copper is, on the contrary, converted into a soluble chloride. The copper salt is subsequently removed by repeated washings and the copper precipitated by iron in the metallic state.

This precipitated copper contains a notable quantity of silver as well as a distinct trace of gold. Thus in 9 successive washings of one tank of ore there were found respectively 4.06, 3.25, 1.05, 0.19, 0.12, 0.06, 0.03, 0.06, 0.04 grains of silver to the gallon of liquor. This silver comes from the ore which has been roasted with common salt as chloride held in solution by the large amount of undecomposed chloride of sodium. Of these various washings the first 3 alone contain enough of the precious metal to pay for working. The treatment is as follows:—

These liquors are first run into suitable wooden cisterns, each of a capacity of about 2,700 gallons, where they are allowed to settle. The yield of silver per gallon is now ascertained by taking a measured quantity, to which are added chlorhydric acid, iodide of potassium, and acetate of lead in solution. The precipitate obtained is thrown upon a filter, and after being dried is fused with a flux, consisting of a mixture of carbonate of sodium, borax, and lamp-black. The resulting argentiferous lead is passed to the cupel, and from the weight of the button of silver obtained the amount of that metal in a gallon of the liquor is estimated.

The liquor from the settling-vat is now allowed to flow into another of slightly larger capacity, whilst at the same time the exact amount of a soluble iodide necessary to precipitate the silver present is run into it from a graduated tank, together with a quantity of water equal to about one-tenth the volume of the *copper liquor*. During the filling of the second tank, its contents are continually stirred, and when filled a little lime-water is added, and the mixture is allowed to settle during 48 hours.

The precipitate formed is chiefly composed of sulphate of lead, iodide of silver, and salts of copper, which latter are readily removed by washing with water acidulated with chlorhydric acid. The precipitate is then decomposed by metallic zinc, which reduces completely the iodide of silver, and to a certain extent the sulphate of lead. There result (1) a solution of iodide of zinc, which after being standardized is employed in subsequent operations to precipitate fresh quantities of silver; (2) a precipitate containing about 4.5 per cent. of silver, 0.06 per cent. of gold, 15.5 per cent. of zinc, and 56.5 per cent. of copper.

The result of nearly 6 months' experience of this process, at the Widnes Metal Works, shows that one-half ounce of silver and 1½ grain gold may be extracted from each ton of ore worked at a total cost of 8d. per ton. A profit of 2s. per ton is thus obtained, — an amount not to be disregarded in works which treat 30,000 tons of ore annually. — *Abstract of a paper read by J. Arthur Phillips before the British Association*, 1870.

GAS MANUFACTURE.

New Process of Gas Manufacture.— In this process, which is patented, and which is at present in operation under the auspices of the Citizens' Gas Light Company, Saratoga, N. Y., the gas is made from crude naphtha in an essentially "new" method.

The naphtha is put into a still and gradually converted into vapor by a steam coil. The vapor is thence conducted into a peculiarly constructed superheater, placed inside a clay or iron retort, set and heated in the usual way. There is in use here one bench of 3, each retort provided with a superheater. The vapor enters the rear of the retorts from the superheater, where it is instantly converted into a fixed gas, and passes into the stand-pipes, and so on to the gas-holder in the usual way, except that no washing, scrubbing, or purification is needed, a simple tank and condensing coil being all that is required.

One bench of 3 will produce 5,000 feet of gas per hour, prepared for distribution, of not less than 20 candle-power, equal to 120,000 cubic feet per day of 24 hours. One bench of 5 will easily produce 200,000 cubic feet per day. The expense of labor is reduced to a minimum; only an engineer and one fireman being necessary. The entire process is so nearly automatic that but little manual labor is required. There is no charging and discharging of retorts, no troublesome stoppage of stand-pipes, or scaling and decarbonizing of retorts, no laborious and disagreeable purifying process. There are no bad odors, smoke, or soot. The first cost of works, it will be readily understood, is much less; scrubbers, washers, and purifiers being dispensed with, and only one-tenth the number of benches being required to produce a given amount of gas, and, owing to the low heats employed, the wear and tear is far less. Another remarkable feature of this gas is its non-condensability in the mains, — none of the drips having yet required to be pumped. The loss by leakage and condensibility is therefore exceedingly small, never having exceeded 3 per cent. The mains in one place, particularly, are laid only 16 inches under the surface for a space of one-half mile, owing to the difficulty of excavating a very hard unstratified rock. But during last winter, with the thermometer often at and below zero, no trouble of condensation was experienced.

Other materials can be used beside naphtha, — any of the products of the oil-wells, such as crude petroleum, dead oil, "still foots," etc. Any oil or oily or fatty matter may be used. In fact, all liquid, semi-liquid, or solid carbonaceous matter can be employed to make gas by this process; and the letters patent fully specify and cover this ground. It is only necessary to observe that, where the materials used do not vaporize (like naphtha, etc.,) by the application of a steam coil, it is only necessary to apply a *sufficient degree* of heat through the aid of a *furnace*, that will convert the material into a vapor, in the first instance; and that this vapor (which is necessarily more or less *condensable*) shall pass into a retort heated to a temperature sufficient to convert it *all* into a *fixed gas*. This is the great novelty of the invention, and gives it the great advantage over the ordinary method of distilling either oils and other hydro-carbons, or coals and the like materials, to produce illuminating gas. If coal is used, it first *distils*, and oil as a *condensable vapor* is eliminated; this, instead of going to make *coal tar* in the hydraulic main as usual, is passed into a red-hot retort, where it becomes a true gas, and nothing else.

This process is a great stride in the art of making gas upon true chemical principles. In the old process, the charge of coal is thrown into a hot retort; a portion next the retort is distilled at a proper temperature to produce a fixed gas; but another portion in the centre of the charge is distilled at a low temperature, which will only yield oily and condensable matter, and this goes to form the *tar* in the hydraulic main. This is the very *essence*, so to speak, of gas, and is a dead loss to the process in a chemical sense. Again, another portion of the charge becomes too highly heated, and is destructively decomposed, forming either a hard incrustation on the sides of the retorts called gas carbon, or clogs the mouth-piece and stand and bridge pipes, in the form of a combined gummy and sooty matter. Although the gas may be formed properly in one part of the retort, before it escapes a portion becomes decomposed and resolved into new chemical combinations, principally carbonic oxide, carbonic acid gas, and free hydrogen. All this is wrong, and to the analytical mind of the scientist, but more especially to the practical mind that comprehends it fully, the whole process of gas-making appears not only absurd but even ridiculous, when compared with the new process. — *Amer. Gas-Light Jour.*

The McCracken Process. — By this process of gas manufacture the tar condensing in the hydraulic main is allowed to overflow, and, being conducted in a fine stream to the rear end of the retorts, enters in company with a certain amount of water which, when it reaches the retorts, is in the state of superheated steam. There results from the tar and the superheated steam a mixture of hydrocarbons and carbonic oxide, which go forward to increase the amount of gas. Retorts of a peculiar construction are employed.

Enrichment of Gas. — In view of the difficulty of obtaining boghead cannel and other coals suitable for the enrichment of gas, considerable use is being made of bitumen from the Island of Trinidad, where there exists a supply practically inexhaustible. This bitumen is used by the Brooklyn (N. Y.) Gas Çompany and gives full satisfaction. — *Amer. Gas-Light Jour.*

Use of Sulphuric Acid in Coal-Gas Purification. — Mr. M. C. Pelouze publishes an article in the "Journal of Gas Lighting," on the use of sulphuric acid for the removal of ammonia from coal-gas, and states that, heretofore, the sulphuric acid was improperly applied, either diluted in scrubbers or more concentrated in purifying-boxes. In both cases the gas takes up some of the acid, and thus deteriorates the pipes and burners. Pelouze besprinkles his purifying material (oxide of iron or sawdust) with water containing 20 per cent. sulphuric acid of 53°B. (spec. grav. 1.53). The material is then exposed to the air in a warm place until sufficiently dried, and is then used. After use sulphuric acid must be added to replace that which was neutralized by the ammonia. When the salt of sulphate of ammonium has accumulated it may be washed out with water, and the solution worked up. Pelouze states that this method also prevents the separation of naphthaline. — *Amer. Chemist.*

Reagent for Detecting Ammonia in Illuminating Gas. — M. Meunier prepares a tincture of the fresh leaves of the *Colcus Verschaftelti* by treating these leaves with absolute alcohol to which a few drops of sulphuric acid have been added. Slips of Swedish filter-paper dyed with this tincture and dried in the open air furnish a valuable test for the presence of ammonia, being turned green by alkalies. The presence of ammonia in coal gas may be ascertained by holding one of the moistened strips for a few moments in a current of the gas. The paper should be preserved in well-stoppered bottles. — *Cosmos.*

Determination of Sulphur in Coal Gas. — Vernon Harcourt's method is as follows: "In my apparatus I use a small Bunsen burner, which gives a flame, scarcely visible in the daylight, of three-quarters of an inch in length, when burning at the rate of a quarter of a cubic foot per hour. The gas is supplied by means of an aspirator with between 20 and 30 times its volume of air. A funnel placed at the top of the cylinder in which the gas burns admits the air through holes in the neck, and distributes it down the sides of the cylinder, while the products of combustion and the excess of heated air are withdrawn from within the funnel through a tube rising from the bottom of the cylinder. This tube fits loosely into another tube, which passes through an India-rubber plug closing the cylinder, and is attached to a system of bulbs, through which are driven the air in which the gas has burned and the liquid used to wash it. From the bulbs they pass into a two-necked receiver placed over the cylinder, whence the air escapes into the aspirator, while the liquid descends through a small tube to the bottom of the cylinder and repeats its course. The liquid used is an ammoniacal solution of copper, the ammonia serving to fix the sulphur compounds, while the copper determines, in presence of an excess of air, the oxidation of sulphite to sulphate." The air which enters the apparatus is freed from sulphur compounds by being passed through an ammoniacal solution of copper. When about 2 cubic feet of gas have been consumed the liquor is drawn off, the apparatus rinsed with water, and the sulphur precipitated as sulphate of barium after the excess of ammonia has been driven off. — *Lond. Jour. of Gas-Lighting.*

Various Formulæ proposed for the Relation between the Quantity of Light produced and the Amount of Gas consumed. — Fred. E. Stimpson. — The author found upon examination that three formulæ had been proposed for this reduction, namely: —

(1) The common one

$$\frac{l}{l'}=\frac{g}{g'},$$

which is expressed by saying that the quantity of light, l, is proportional to the quantity of gas, g, consumed; (2) that produced and used by Bunsen and Roscoe, Phil. Trans., CXLIX. (1859), page 884,

$$\frac{l-l'}{l'-l''}=\frac{g-g'}{g'-g''},$$

which is expressed by saying that for a given burner the increase of light is proportional to the increase of the quantity of gas consumed; (3) "Farmer's Formula," proposed by Professor Silliman at the Salem Meeting of the American Association,

$$\frac{l}{l'}=\frac{g^2}{g'^2},$$

which is expressed by saying that the light is proportional to the square of the consumption. These three formulæ, transposed so as to express the value of l, become,

$$(1.)\quad l=\frac{l'}{g'}-g \text{ or } l=Ag.$$

$$(2.)\quad l=\frac{l'-l''}{g'-g''}\,g-\frac{l'-l''}{g'-g''} \text{ or } l=Ag-B.$$

$$(3.)\quad l=\frac{l'}{g'^2}\,g^2 \text{ or } l=Ag^2.$$

Mr. Stimpson had collected from various publications upwards of 120 independent series of determinations of the relative illuminating power of gas consumed at various rates from different burners. These burners comprised single jet, union jet, or fish-tail, slit or bat's-wing, and argand; each set contained from 2 to 10 single determinations. These series, together with some of his own determinations, were represented in the form of curves, and by means of the magnesium lantern projected on to a screen for inspection. From the results of observations thus far made, he concluded that Bunsen's and Roscoe's formula (a straight line cutting the axis g) would represent the greatest number of series, and particularly the series belonging to the argand burners.

That for those series belonging to the jet, the fish-tail and bat's-wing burners, the common formula (a straight line passing through the origin), which is a modification of Bunsen's, in which $B = 0$, very closely represents the relation found by experiment. The number of cases in which the series or any considerable part of the series could be represented by formula 3 (a parabola) were very few. Mr. Stimpson found, however, that when a gas flame was on the verge of the smoky condition, a tangent to the curve would almost always pass through the origin, showing that for a limited range of consumption at that point the light is proportional to the consumption. One other point was also very apparent; such is the influence of the burner upon the flame, that, in order to get the best result for any given consumption, the burner must be of the kind best fitted for that particular consumption. — *Amer. Gas-Light Jour. from Proc. Amer. Association.*

Farmer's Theorem. — Many of Professor Silliman's experiments, on which he relied to establish "Farmer's Theorem," were performed by mixing a very rich gas, which could not be burned in a 15-hole argand-burner at the rate of 5 feet an hour, with a poor gas of known power. Mr. Stimpson objects to this "method of mixtures." Professor Silliman subsequently performed a limited number of experiments by mixing a gas of known power with hydrogen, and determining the candle-power of the mixture. He finds the results sufficiently in accordance with theory to justify him in asserting the applicability of the following rule: To find the candle-power of a gas having, for example, an intensity greater than 20 candles, mix the rich gas of unknown power with a poorer gas of known power in such proportions that the intensity of the mixture shall not be greater than 20 candle-power when consumed at the agreed rate of not over 5 cubic feet per hour. Then, to compute the candle-power of the rich gas, subtract the intensity (b) of the poor gas from the intensity (d) of the mixture; multiply the remainder by the volume (a) of the poor gas; divide the product by the volume (c) of the rich gas; add to the quotient the intensity (d) of the mixed gas, and the sum is the intensity (x) of the rich gas sought. That is, since

$$\frac{ab + cx}{a + c} = d, \text{ then } x = \frac{(d - b)\,a}{c} + d.$$

—*Amer. Jour. Science.*

Influence exerted on the Illuminating Power of Gas by the Presence of Carbonic Acid. — That the presence of carbonic acid in illuminating gas should exert some influence on its illuminating power, it would be very natural to suppose. Owing to the (until recently) general use of lime for the purification of gas, no careful and direct experiments on the subject have been published. The use of oxide of iron in the place of lime, and the consequent retaining by the gas of the carbonic acid to a certain extent, render experiments on the subject desirable. Such experiments were made in the year 1863 by Prof. W. B. Rogers, assisted by Mr. Fred. E. Stimpson, present Inspector of gas and gas-meters for the State of Massachusetts. The experiments were performed by mixing ordinary Boston illuminating gas (containing about 2.5 per cent. of carbonic acid on the average) with different quantities of carbonic acid, and burning first the ordinary gas and then the mixture in the same 15-hole argand burner, the gas in both cases being passed at the same rate (5 feet per hour) through the same dry meter. It was found that the gas for every additional per cent. of carbonic acid lost 6 per cent. of its illuminating power up to a certain point, and that further addition of carbonic acid caused further decrease, but in a smaller ratio. All light was destroyed by the addition of 58 per cent. of carbonic acid. — *Fred. E. Stimpson, at the Troy Meeting of American Association.*

The non-luminosity of the Bunsen flame is not due, according to Knapp, to the fact that the mixture of air and gas affords a more complete combustion of the latter. He finds that chlorhydric acid, carbonic acid, or even pure nitrogen, causes the same effect, and therefore believes that the loss of light is due partly to the cooling of the flame, but mainly to the *dilution* of the gas. — *Journ. für prakt. Chemie.*

CONDITION OF CARBON AND SILICON IN IRON AND STEEL.

At a meeting of the Iron and Steel Institute held at Merthyr Tydvil, in South Wales, in September of the last year (1870), Mr. G. J. Snelus read a paper with the above title. This paper contained the results of a long course of experimental inquiry, instituted with a view to determine the conditions in which the two non-metallic bodies, carbon and silicon, exist in iron and steel. Dr. Perry had said, in his celebrated work on "Iron and Steel," that not a trace of graphite could be detached by the point of a pen-knife from the fractured surface of highly graphitic iron; but Mr. Snelus had proved the incorrectness of this statement by examining some pig iron which had cooled slowly under a mass of slag, and which had in consequence very large crystals. From the surfaces of these crystals the graphite could not only be separated with the point of a pen-knife, but even with the finger-nail; and when the graphite was removed the iron underneath rusted rapidly in a damp atmosphere.

By pulverizing pig iron and then using the magnet, a considerable amount of graphite was separated. In *spiegeleisen* the carbon was found to be almost wholly combined. The author had never found as much as 5 per cent. of combined carbon in pig iron, although many analyses had been published in which the carbon was put down at even 6 per cent. According to Mr. Snelus there is no pig iron that is destitute of silicon, and he had never met with a case in which either steel or wrought iron was *totally free* from it. Good Bessemer and tool steel rarely contains more than 2 or 3 parts in 10,000. One part of silicon in 1,000 of Bessemer metal, renders it hard and brittle when cold. In ordinary Bessemer pig iron, it is present in quantities varying from 1 to 4 per cent. The author gave it as his opinion, from experimental inquiries, that silicon is dissolved or "occluded" in iron in the same way that carbon is, but that the solvent power of the metal is so much greater for silicon than for carbon that it is quite a rare thing, even if it ever occurs, for silicon to separate in a free state from the iron. Mr. Bessemer confirmed the remarks of Mr. Snelus as to the universal presence of silicon even in the best Sheffield steel; and alluding to the prevailing opinion that the presence of silicon was injurious, stated as his opinion that, on the contrary, the presence of a small quantity of silicon was beneficial.—*Reported in Nature, Sept.* 15, 1870.

THE CHEMISTRY OF THE BESSEMER PROCESS.

At the Troy Meeting of the American Association for the Advancement of Science, Lieut. C. E. Dutton, U. S. A., read a paper on this subject, of which the following is an abstract:—

"Cast iron—the raw material from which the malleable metal is made—may be formulated approximately as follows:—

Silicon (Si),	.5 to 3 per cent.
Phosphorus (P),	.05 to 2 per cent.
Manganese (Mn),	.0 to 20 per cent.
Sulphur (S),	.25 to 2 per cent.
Carbon (C),	.2 to 5 per cent.
Iron (Fe),	90 to 96.5 per cent.

"It is a rare thing if pig iron do not contain every one of these elements, excepting manganese, in proportions within the limits here given. Although manganese is oftener absent than present, yet its importance is so great in the metallurgy of iron, that I have deemed it necessary to introduce it into the discussion, particulary as its importance is greatest of all in the Bessemer process. The percentages given are neither the highest nor the lowest, but may be considered as the extremes of the normal varieties. Some few extraordinary brands have been known to exhibit very remarkable constitutions, such as 8 per cent. of carbon, and 12 to 15 per cent. of silicon; but these are mere curiosities of metallurgy, and not useful or practicable materials."

All these elements are readily oxidized, and, according to Lieut. Dutton, in the order in which they have been mentioned, the carbon being the last impurity to be burned out. After reviewing the ordinary methods of converting cast iron into wrought iron and the order and manner of the elimination of the various injurious substances, Lieut. Dutton says:—

"There is not a substance employed, nor a combination induced or resolved, in the Bessemer process, which has not been repeatedly made use of for more than 30 years in the commonest practice of Europe and America. The differences, which are many and great, are all *mechanical*, and the Bessemer process may, with strict accuracy, be said to be *the employment of entirely new mechanical methods and appliances for effecting old and familiar reactions*.

"The gist of the Bessemer process lies in this: that the metal is kept fluid from the beginning to the end,—from the time when the metal is first touched by the oxygen, until it is finally cast into workable and definite shape in the ingot moulds. This implies an enormous increase of heat during the working, for wrought iron is very difficultly fusible in the most intense heat of the blast furnace, and not at all so in the reverberatory furnace. But in this method, not only is the purified wrought iron melted to a state of extreme fluidity, but it retains a surplus of heat sufficient to keep it liquid for a considerable time after it has received an admixture of 5 to 10 per cent. of cast iron at less than half its temperature, and it can still be poured in a thin stream, and cast with facility. Indeed, no other process known to the arts develops a degree of heat at all comparable to this, and the most surprising thing connected with it is the simple and unexpected means by which it is obtained."

The cast iron intended for conversion must be as free as possible from sulphur and phosphorus, since in this process the sulphur is removed with difficulty, and the phosphorus, practically, not at all. The metal is first melted in a cupola furnace, whence it is run into the "converter" which receives the charge (12,000 pounds) in a horizontal position, in order that the metal may not run into the tuyere-holes in the bottom. When charged the blast is let on and the vessel righted. The action commences immediately.

"As in the puddling furnace, the first change is in the oxidation of iron and silicon. The silicon becomes silicic acid, and enough of the iron oxidizes to satisfy the affinities of the acid, and does not decompose during the remainder of the blast. It is during this stage of the process that the remarkable heat of the conversion is developed. It will be remembered that when silicon oxidizes it takes up 3 equivalents of oxygen. Carbon takes up only 1 in this process, becoming carbonic oxide. It is a common error to suppose that any very great quantity of heat is generated by the combustion of the carbon,—that is, as compared with that derived from the silicon. The heat generated by the silicon burning to silicic acid will be found by the application of the coefficients and formulæ of the mechanical theory of heat to be from 2½ times to 3 times greater than that generated by the burning of the carbon to carbonic oxide. Another circumstance of importance is that the silicic acid remains as a dense fluid in the converter, no part of its heat being lost, except such as is carried out of the converter by the atmospheric nitrogen, and none is rendered latent by converting it into vapor; while the carbon is vaporized, a physical change absorbing much heat, and the vapor thus formed is carried out of the converter at a very high temperature. Hence will be seen the necessity of employing irons containing high percentages of silicon. At least 2 per cent. of this element is essential, any less quantity being insufficient to generate heat enough to keep the iron thoroughly liquid and fluent until the end of the casting process. It is often asserted that irons for Bessemer conversion must be 'gray irons,' as they are called, that is, irons rich in carbon. Now, although this happens, as a rule, to be true enough, it is apt to lead to misapprehension. The fact that Bessemer pig irons are carbonized varieties is an accident and not an essential feature. What *is* essential is that it should contain a large quantity of silicon, and very little — indeed the least possible — of sulphur, phosphorus, and manganese. Now, a pig iron containing much silicon, and no sulphur or manganese, is pretty sure to contain a high percentage of carbon, as all smelters are aware. This fact is a feature of the blast furnace, and almost without exception. If an iron could be produced with much silicon, a little carbon, no phosphorus, it would, I think, be not altogether unsuited to the Bessemer treatment. In a word, the quantity of carbon is approximately immaterial except so far as it implies proper conditions with respect to other elements. The main element required is the silicon, and not the carbon.

"Of equal importance and absolute necessity is the absence of phosphorus. This element is the arch-enemy of the iron-maker, but it is the very scourge and pestilence of the steel-maker. I venture to assert that the most formidable problem which has arisen with respect to any process dealing with iron or steel is the phosphorus problem in the Bessemer converter. A few pounds of phosphorus in a ton of Bessemer railway bars render them unfit even for the scrap-heap. Fifteen-hundredths of one per cent. of it is sufficient to render common wrought iron worthless, but one-tenth of that quantity will ruin Bessemer metal past all remedy. But the smallness of the quantity which is capable of working this terrible destruction is by no means the worst evil. There are two other circumstances of an appalling nature, namely, the almost universal presence of phosphorus, and the absolute impossibility of eradicating it by any process at present known.

"I have already ventured the opinion that phosphorus increases its affinity for iron with every increase of heat, — at least relatively, if not absolutely. This fact seems to be absolutely. If we accept it, we can instantly explain what seem, otherwise, to be many anomalies and contradictions. It will explain to us why, in the great heat of the blast furnace, it leaves every other combination, and enters the iron; why, in the much lower heat of the puddling furnace, it seems to waver between staying with the iron, or forming a new alliance with oxygen, ready to choose either at the influence of any third substance which may affect the question; why, in the Bessemer process, it clings to the iron with a desperate tenacity which nothing seems able to resolve. These three facts then are all of them formidable: 1st. That a minute quantity of phosphorus is capable of working terrible injury, and that it is omnipresent throughout nature;

2d. That whatever quantities of it are charged into the blast furnace, as fuel, flux, or ore, are almost wholly concentrated into the resulting pig iron; and, 3d. That no portion is eliminated in the Bessemer converter. How, then, can we hope to make a metal which is good for anything?

"Fortunately for our purposes there are ores, fluxes, and fuels, which contain only extremely minute proportions of phosphorus, though I doubt whether there be any such materials absolutely free from it. But there are found those which are sufficiently so for all practical purposes, for there is a limit below which even phosphorus ceases to be injurious to the metal. These furnace materials are somewhat rare, and confined to a few favorable localities, but their existence has been demonstrated fully in Europe, and I am sanguine that they can be found, nay, they are already found, in the United States.

"With respect to *sulphur*, the reactions in the Bessemer converter do not differ from those of the puddling furnace. It is removed chiefly about the middle of the heat. Although no careful and systematic analyses of the slag have yet been made, it is probable that sulphide of iron will be found there in small quantities, provided the pig metal contain it to the extent of 2 or 3 per cent. It is by all means desirable that the pig should be as free from sulphur as from phosphorus. Its effects are always deleterious, although it requires a larger amount of sulphur than phosphorus to cause an equal amount of damage. Like phosphorus, too, it is one of the universally diffused elements accumulated by organic agency, and much more abundantly in fuel than in ores. But sulphur is, on the whole, not a very formidable difficulty, because it can be sufficiently removed from most irons. A small quantity of manganese is its best antidote, with which it readily combines as a sulphide, with a stronger affinity than for irons.

"The oxidation of the carbon is the final reaction of the blast. It begins before the silicon is removed and continues with increasing vehemence until two-thirds or three-fourths of the time has elapsed, when it begins to show signs of exhaustion. The product is carbonic oxide, with possibly a slight admixture of carbonic acid. The silicon stage very considerably overlaps the carbon stage, — indeed, when the percentage of silicon is very high it continues to oxidize in decreasing quantity to the end."

Alluding to the almost instantaneous "dropping" of the flame at the close of the operation, while a small amount of carbon and other impurities remain and resist further oxidation, Lieut. Dutton says: —

"A plausible explanation is this: When two combustibles are intermixed, like oxygen and hydrogen, or hydrocarbon gas, it is well known that the relative proportion of the two elements in the mixture influences the readiness with which they combine. Thus oxygen and hydrogen cannot combine explosively, unless their proportions lie within certain definite and rather narrow limits. May not the same law hold good in the present case? It is certain, or nearly certain, that the iron either does not oxidize in the bath during the blow, except in quantity sufficient to furnish a base for the acids present, or if it oxidizes beyond that, it is immediately reduced again, leaving little or no free oxide of iron in the bath. But after the change of flame all this is reversed, and iron oxidizes rapidly and freely, and remains undecomposed, while the residual traces of the other elements as suddenly cease to oxidize rapidly. I freely grant that in referring this back to what is supposed to be a conceded, but unexplained, law, we are merely putting the question in another, a more general, and more abstract shape; still it is, in a qualified sense, an explanation."

After a discussion of the effect of the last stage of the process, which is the addition of certain amount of melted *spiegeleisen*, — a pig iron containing from 4 per cent. upwards of manganese and a considerable percentage of carbon, — the paper closes with the definition of Bessemer metal as a *cast wrought iron*, and with a comparison of its merits for various purposes as compared with wrought iron and steel.

HEAT OF COMBINATION OF BORON AND SILICON WITH CHLORINE AND OXYGEN.

The products of the oxidation of boron and silicon render the direct determination of the heat evolved by their combustion impossible. Much interest attaches to such a determination, especially in the case of silicon, which plays such a part in metallurgical operations, as, for example, in the Bessemer process (see p. 178). Troost and Hautefeuille have presented to the *Société Chimique de Paris* a paper on this subject (published in the "Bulletin Mensuel" for March, 1870). They say: —

"In order to obtain these constants it has been necessary to proceed in an indirect manner, and to pass through intermediate combinations. Thus, in the case of silicon, we have been obliged to have recourse to nitro-hydrofluoric acid, the only reagent capable of attacking at ordinary temperatures the various modifications of silicon. Even this reaction, valuable as it is, does not afford the means of determining anything except the differences between the amounts of heat evolved by the combustion of the different modifications of silicon. In order to determine the heat of combination of one modification, amorphous silicon, we were obliged to conduct the experiment in such a manner as to cause the silicon to be attacked by chlorine in the muffle of the calorimeter. This was effected by mixing with the silicon a small quantity of amorphous boron, which, in combining with the chlorine, disengages enough heat to raise a portion of the silicon to a temperature so elevated that the combination with the chlorine begins, and once begun, it continues until the reaction is complete. All the experiments were performed with Favre's calorimeter."

The following results were obtained: —

			For every gram taken there are disengaged,	
1 equivalent of amorphous boron in combining with oxygen disengages....	158,600	heat units.	14,420	heat units.
1 equivalent of amorphous boron in combining with chlorine disengages...	104,000	"	9,455	"
1 equivalent of chloride of boron acting on 140 times its weight of water disengages........................	79,200	"	7,200	"
1 equivalent of amorphous silicon in combining with oxygen disengages....	109,620	"	7,830	"
1 equivalent of amorphous silicon in combining with chlorine disengages...	78,820	"	5,630	"
1 equivalent of chloride of silicon acting on 140 times its weight of water disengages......................	40,820	"	2,915	"
1 equivalent of amorphous silicon in being converted into the crystallized variety disengages..............	4,060	"	290	"

"Hence it appears that, weight for weight, the calorific power of carbon is less than that of boron, and that of silicon is less than that of carbon when the carbon is oxidized to carbonic acid. If, however, we compare *equivalent* weights, we find that an equivalent of silicon gives out twice as much heat as an equivalent of carbon, the amount of oxygen entering into combination being the same in both cases. Moreover, when the carbon is simply converted into carbonic oxide, as is the case in many metallurgical operations, it gives off only about one-third as much heat as the same weight of silicon in passing to the state of silica."

The authors further speak of the importance of using iron containing a considerable amount of silicon in the Bessemer process, alluding also to the fact that the product of the combustion of carbon being gaseous, carries off heat from the converter, while the silica formed remaining in solid state, the heat evolved in its production is all utilized in maintaining the temperature of the bath.

ALIZARINE.

In spite of the many investigations of madder which have been made, chemists are still in doubt as to the nature of many of its constituents. Some attribute its coloring powers to the presence of at least two substances, — alizarine and purpurine, — while others say that only one of these produces the true madder colors.

Alizarine was discovered and obtained from madder as a crystalline sublimate by Robiquet and Colin in 1831; but little importance attached to this discovery until Schunck, in 1848, showed that all the finest madder colors contain only alizarine combined with bases and fatty acids. The second coloring matter, termed purpurine, was discovered by Persoz. It contributes to the full and fiery red color in ordinary madder dyeing, but dyes a bad purple, alizarine being essential to the latter. Purpurine disappears during the purifying processes of soaping, etc., being far less stable than alizarine.

Alizarine can be obtained in yellow, needle-shaped crystals by simple sublimation from the dried madder, although it is not regarded as existing as such in the madder-root. A crystalline glucoside, termed rubianic acid (Schunck), is contained in the root, and this splits up into alizarine and glucose. The formula assigned by Schunck to alizarine was $C_{14}H_{10}O_4$, while Strecker held it to be $C_{10}H_6O_3$. Some five years since, Martius and Griess obtained a coloring matter possessing Strecker's formula; it was not, however, alizarine, but was supposed to be isomeric with it. Some time after the discovery of this supposed isomer of alizarine, Graebe commenced his researches on *quinone*. In these researches when it had been shown that chloroxynaphthalic acid was a quinone acid, Graebe and Liebermann thought it probable that alizarine belonged to the quinone series. On treating a specimen of the natural coloring matter with powdered zinc, they obtained a substance of the composition $C_{14}H_{10}$. This hydrocarbon formed with picric acid a red compound and, in fact, possessed all the properties of anthracene as obtained from coal-tar. Having obtained anthracene from alizarine, it now remained to form alizarine from anthracene; and in this Graebe and Liebermann were successful. (Their process was noticed in the preceding volume of the "Annual of Scientific Discovery," p. 205.) Heating anthraquinone ($C_{14}H_8O_2$), an oxygenated derivative of anthracene discovered by Laurent, with bromine, they obtained a brominated compound ($C_{14}H_6Br_2O_2$), which, on being treated with caustic potash at a temperature of 180° C., yielded the potassium salt of alizarine. From this alizarate of potassium the alizarine is separated by chlorhydric acid. This process has since been modified by the substitution of a cheaper reagent in the place of bromine. This reagent is found in common sulphuric acid; on heating anthraquinone with sulphuric acid at a high temperature, a sulpho-acid is formed ($C_{14}H_6O_2,2HSO_3$), which, on treatment with hydrate of potassium, yields alizarate of potassium and sulphite of potassium.

Artificial alizarine is entirely identical with the coloring matter obtained from the madder-root. Both products crystallize in needles which are usually curved, especially when small. They dissolve in caustic alkalies, forming violet solutions of the same tint. When applied to mordanted fabrics, they produce exactly the same colors, bearing the treatment with soap equally. They possess also precisely the same tinctorial value. When dissolved in alcohol they produce, with acetate of copper, a purple solution of precisely the same shade of color. When examined with the spectroscope, their potassic solutions produce the same absorption-bands. A good deal has been said about anthracene, it being assumed that it cannot be obtained in large quantities. It must be remembered, however, that tar distillers have had, as yet, but little experience in separating this substance. Mr. Perkin believes, from his experiments, that coal-tar contains considerable quantities of this hydrocarbon.

There can be no doubt that the kind of coal, as well as the temperature employed in the gas-works, influences the quality of the coal-tar, as a source of anthracene; but upon these points no definite information has been obtained up to the present time.— *On Artificial Alizarine, by W. H. Perkin, F.R.S., Journ. Chem. Soc., May,* 1870.— *On the Artificial Production of Alizarine, by Prof. H. E. Roscoe, F.R.S., Proc. Roy. Inst.,* 1870.

RIVER POLLUTION.

The Commission appointed in 1868 to inquire into the pollution of rivers, have presented to the British Parliament a very interesting and valuable report.* The commissioners were Sir William Denison, Dr. Frankland, and Mr. J. C. Morton. They class river pollutions under two general heads: "sewage" and "manufacturing refuse." The chemical difference between polluted and unpolluted water is thus defined: "Absolutely pure water is not to be found in nature. Even at the moment of its condensation in the atmosphere from invisible vapor to visible cloud, water absorbs gases and becomes also contaminated with a fine dust which is everywhere floating in the air. When it falls to the earth as rain, it percolates through strata or flows over surfaces more or less soluble, and dissolves, according to circumstances, quantities of solid matter, varying generally from about 3 pounds to 50 pounds in 100,000 pounds of water. In addition to these inevitable impurities, natural and unpolluted water is not unfrequently turbid from insoluble substances suspended therein in a finely divided condition.

"The following are the chief characteristics of unpolluted water: It is tasteless and inodorous, possesses a neutral or faintly alkaline reaction, rarely contains in 100,000 pounds more than one-half pound carbon and one-tenth pound nitrogen in the form of organic matter, and is incapable of putrefaction even when kept for some time in close vessels at a summer temperature.

"Of the different kinds of pollution affecting rivers, animal organic matter as it occurs in sewage is that which renders water not only most offensive to the senses, but most likely to injure health both by its gaseous emanations and by its deleterious effects when used as a beverage. Rivers so polluted frequently contain from 1 pound to more than 2 pounds of organic carbon, and from one-third pound to three-fourths pound of organic nitrogen in 100,000 pounds. Pollution by vegetable organic matter, such as that caused by dye and print works, stands next as regards offensiveness; water so polluted being excessively unpleasant not only to the sight, but also, in warm weather, to the sense of smell. It often contains in 100,000 pounds twice as much organic carbon as is present in water polluted by sewage, but, owing to the comparatively small proportion of nitrogen in vegetable substances, it rarely contains more than one-third pound of organic nitrogen. Chemical works contribute chiefly mineral impurities, which often communicate to water extreme hardness, and other disagreeable and even poisonous properties."

---

* First Report of the Commissioners appointed in 1868 to inquire into the best Means of Preventing the Pollution of Rivers. (Mersey and Ribble Basins.) Vol. I. Reports and Plans. London, 1870.

The Commission made numerous analyses of the water of the various streams in the district under examination, directing their inquiries mainly to: (1) Total solid matters in solution; (2) organic carbon; (3) organic nitrogen; (4) ammonia (in the form of carbonate of ammonium); (5) nitrogen, as nitrates and nitrites; (6) total combined nitrogen; (7) chlorine; (8) hardening constituents; (9) suspended matters. In regard to the alleged self-purification of polluted streams they say: —

"It has often been stated, but, so far as we know, without any proof, that the organic matter contained in sewage and other similar polluting materials is rapidly oxidized during the flow of a river into which such materials are discharged. Thus it has been asserted that, if sewage be mixed with 20 times its volume of river water, the organic matter which it contains will be oxidized and completely disappear, while the river is flowing '*a dozen miles or so*.' (*Report of Royal Commissioners of Water Supply*, p. lxxix.) We thought it very undesirable that a subject of such vital importance to our inquiry should any longer rest on mere opinion, and we therefore determined to submit it to careful experimental investigation. During our winter visit to the basins of the Mersey and Ribble, a very favorable opportunity presented itself for the solution of this important problem. The river Mersey, after receiving the drainage of many towns and manufactories above the Stretford Road Bridge, flows thence 13 miles to its junction with the Irwell without encountering any other material source of impurity, although its volume is somewhat augmented by unpolluted affluents. The river Irwell, after passing Manchester, falls over a weir at Throstlenest and runs 11 miles to its junction with the Mersey without further pollution. Lastly, the river Darwen, which is greatly polluted by the sewage of Over Darwen, Lower Darwen, and Blackburn, joins the Blakewater just below the latter town, and then flows 13 miles to near its junction with the Ribble without further pollution, although its volume is more than doubled by various unpolluted affluents.

"We took samples of water at the top and bottom of the courses of these various rivers at the places just indicated." From the results of the analysis of these samples, and from other experiments undertaken in order to decide this point (for which the reader is referred to the original document, pp. 19 and 20), it is evident that, "so far from sewage mixed with 20 times its volume of water being oxidized during a flow of 10 or 12 miles, scarcely two-thirds of it would be so destroyed in a flow of 168 miles at the rate of 1 mile per hour. Whether we examine the organic pollution at different points of its flow, or the rate of the disappearance of the organic matter of sewage, when the latter is mixed with fresh water and violently agitated in contact with air, or, finally, the rate at which dissolved oxygen disappears in water polluted with 5 per cent. of sewage, we are led in each case to the inevitable conclusion that the oxidation of the organic matter in sewage proceeds with extreme slowness even when the sewage is mixed with a large volume of unpolluted water, and that it is impossible to say how far such water must flow before the sewage matter becomes thoroughly oxidized. It will be safe to infer, however, from the above results, that there is no river in the United Kingdom long enough to effect the destruction of sewage by oxidation."

The pollutions of the rivers by sewage and by various sorts of manufacturing refuse is thoroughly discussed, as are also the various remedial expedients that have from time to time been proposed, and, in conclusion, a strong expression is given in favor of the system of irrigation where practicable, at least as far as the sewage of towns is concerned. "Manufacturers, also, will generally find the land the best recipient of their waste products. The spent liquors from tan-yards may thus be completely turned to agricultural use. Some of the foul liquids from wool-washing will also be a serviceable addition to sewage used in irrigation. As to other polluting materials, — those from calico-print and silk works, for example, — which plants cannot assimilate, manufacturers will have to resort to subsidence or filtration; and individual cases will doubtless be met with in which want of available land will impose serious difficulties in the way of efficient purification; it is therefore proper to add that, in any enactment on the subject, ample time should be allowed to those who are earnestly endeavoring to abate any nuisance with which they are chargeable."

The Commissioners conclude with the recommendations that the casting of any solid matters, of whatever kind, into rivers and running waters, as well as the discharge of any polluting liquids into any river or stream, be forbidden by law, and that all the rivers and streams in England be placed under the superintendence of a central authority or board (whose duties are defined), who shall be qualified to deal with all questions connected with the pollution of water and the water supply.

Having in view, at present, only the chief sources of pollution in the basins of the Mersey and Ribble, and the methods of cleansing now available, they suggest that the following liquids be deemed polluting and inadmissible into any stream: —

"(*a.*) Any liquid containing, *in suspension*, more than 3 parts by weight of dry mineral matter, or 1 part by weight of dry organic matter, in 100,000 parts by weight of the liquid.

"(*b.*) Any liquid containing, *in solution*, more than 2 parts by weight of organic carbon, or 0.3 part by weight of organic nitrogen, in 100,000 parts by weight.

"(*c.*) Any liquid which shall exhibit by daylight a distinct color, when a stratum of it 1 inch deep is placed in a white porcelain or earthen-ware vessel.

"(*d.*) Any liquid which contains, *in solution*, in 100,000 parts by weight, more than 2 parts by weight of any metal except calcium, magnesium, potassium, and sodium.

"(*e.*) Any liquid which, in 100,000 parts by weight, contains, *whether in solution or in suspension*, in chemical combination or otherwise, more than 0.05 part by weight of metallic arsenic.

"(*f.*) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than 1 part by weight of free chlorine.

"(*g.*) Any liquid which contains, in 100,000 parts by weight, more than 1 part by weight of sulphur, in the condition either of sulphuretted hydrogen or a soluble sulphuret.

"(*h.*) Any liquid possessing an acidity greater than that which is produced by adding 2 parts by weight of real muriatic acid to 1000 parts by weight of distilled water.

"(*i.*) Any liquid possessing an alkalinity greater than that produced by adding 1 part by weight of dry caustic soda to 1,000 parts by weight of distilled water."

UTILIZATION OF SEWAGE. THE PHOSPHATE PROCESS.

The process for the purification and utilization of sewage, proposed by David Forbes and Dr. Price, is founded on the fact that certain mineral phosphates, easily obtainable, especially those containing aluminum, when in a hydrated or freshly precipitated state, eagerly combine with the organic matter contained in the sewage, it being sufficient merely to agitate them in the most fetid sewage, to deprive it of all its odor and color, even if tinctorial substances of great intensity be present in the solution at the same time; whilst the phosphate of magnesium combines with the ammonia contained in the sewage, and precipitates it also in the state of the double phosphate of ammonium and magnesium.

The precipitate subsides rapidly, and the water drawn off is quite transparent and colorless, and has so little perceptible taste that it may be drank without repugnance, provided one can banish from his mind the idea of the filthy source from which it was obtained. The process is an extremely simple one, and requires nothing beyond a reservoir for holding the sewage whilst it is submitted to the operation. The phosphates are preferably added in the state of solution in sulphuric or chlorhydric acid to the sewage, and their precipitation in the hydrated form, along with the organic matter in the sewage, and with more or less of the ammonia (dependent on the strength of the sewage and the amount of time during which it is allowed to stand), is instantaneously effected by the addition of a small quantity of milk of lime, just sufficient to neutralize the acid which holds them in solution; the deposit subsides rapidly, and the supernatant water may at once be run off, and discharged into the river.

In reply to two questions which would naturally be asked, — (1), Whether the water discharged after this treatment is sufficiently pure to be permitted to flow into the rivers; (2), Whether the valuable constituents of the sewage have been precipitated, — Forbes says: "As regards the phosphate process, we do not claim that the affluent water is by anything like as pure as the water supplied for drinking purposes, but are content with showing that it is as transparent and colorless as ordinary river water; that it can be taken into the mouth, and even drank, without repugnance; that fishes can live in it; and, most important of all, that it is not only free from any offensive smell, but that it may be kept for months, and a sample has actually been kept through the entire hot summer of this year, without showing any tendency to putrefy, or emit any disagreeable odor. So that, for the above reasons, we believe that the affluent water from the phosphate process may be allowed to flow directly into the rivers, without injury either to the fish in them, or to the health of the inhabitants on their banks.

"Coming now to the second question, I would premise by stating that I believe the agricultural value of sewage has, in general, been much over-estimated. That the excreta may have originally represented a value of from 8 to 20 shillings per head, as estimated by various writers, is not improbable; but it is as incorrect to regard the sewage as representing the same value as the original excreta, as, for example, to assert that the water in a barrel, into which a bottle of brandy worth 5 shillings has been poured, is equal in value to the original brandy; the whole of the brandy could be recovered by distillation, but probably at a cost greater than its value; and this would also be the case with sewage, if we attempt to extract the entire manurial contents.

"Chemists are all agreed that no chemical combinations are known by which the whole of the sewage contents, valuable for agriculture, can be precipitated; and in our attempts, fully recognizing this, we have only endeavored to extract so much as will leave the affluent water in a condition sufficiently pure as to be innoxious. In regard to the ammonia, the phosphate process converts it into its most insoluble known compound, the double phosphate of ammonium, and magnesium; and the extent to which it is recovered, is dependent upon the length of time allowed for subsidence, and the solvent action of the water, whilst experiments made with London sewage show that the purified sewage retains but a mere trace of organic matter. A most important feature of the phosphate process, however, — one in which it differs from all those previously proposed, — is the fact that the substances employed in the purification are only such as really augment greatly the agricultural value of the precipitated manure, and thus make it sufficiently valuable to bear the cost of transport to a distance. The solid deposit from sewage, when considered as a manure, is admitted to be but of extremely little value, and other processes in use, by employing clay or other worthless substances, diminish the value of the resulting manure to such an extent that it is utterly worthless except in the immediate vicinity of the works. On the other hand, in the new process, what is added are compounds rich in phosphoric acid in a state of combination available for immediate assimilation by the plants themselves.

"The natural phosphate of aluminum, which we specially recommend, is a product which at present has no commercial value, and occurs in the West Indian Islands in such enormous quantities, that on one island alone the report of the survey estimates the deposit at no less than 9,000,000 tons. Many other natural phosphatic deposits, found both in this country and elsewhere, are also capable of furnishing an abundant supply of material well suited for carrying out this process at but a very small expense." — *From a paper read before the British Association at Liverpool, by David Forbes, F.R.S.*

CHEMICAL CLIMATOLOGY.

For the last few years Angus Smith has interested himself, in connection with his work as Inspector under the Alkali Act, with inquiries into the condition of the air in various localities in England, not confining himself, however, to places where there exist manufactories, the influence of which would naturally be supposed to be felt. It was once supposed that the differences in the condition of the atmosphere were such as not to be appreciated by chemical analysis; but although there is still much to be desired in the methods and accuracy of the chemical examination, enough progress has been made to enable us to give such an account of the state of the atmosphere in any given place, that it is possible to say, without difficulty, whether it may be considered as tainted by manufactures, or whether it has a large amount of organic matter in it, and, to a small extent, to answer the question as to the condition of that matter, as it is of importance to distinguish it from that caused by manufacturing processes. The work is still in hand; it is hoped that materials will be found in it for the beginning of a system of examination of climates, certainly of artificial climates, including places imperfectly ventilated, as well as those near manufactories. The modes by which air has been studied are (1) By the usual examination for the gases oxygen and nitrogen (Bunsen's method); (2) examination for carbonic acid (Pettenkofer's method); (3) examination for ammonia (the Nessler-Wanklyn method); (4) albuminoid ammonia (Wanklyn's method); (5) nitric acid (Wanklyn's method); (6) rapidly and (7) slowly oxidizable matter (by washing the air and using permanganate of potassium); (8) chlorides and sulphates; (9) examination of the rain for the same matters with the exception of the gases. Although our knowledge is still very limited with regard to the conditions of the air tending to produce disease, and although there are so many other considerations tending to confuse and bewilder the investigator, yet great importance already attaches to these investigations, and the results thus far obtained are extremely interesting.

Oxygen. — The earliest examinations of chemists were directed to the amount of oxygen and carbonic acid in the air, and the subject of these two gases was admirably worked up by Regnault and De Saussure. "It is abundantly established that the air does differ in the amount of oxygen, but the differences are very small when stated in figures. If we use percentages we throw all the ordinary distinctions into fractions, and a fraction always appears small. It would have been better to have stated the amount of gases in all cases in a million parts. If it required nearly a per cent. of impurity to do us any injury it might be convenient to use per cents., but, so far as I can make out, one of the greatest causes of difference in the air of our large cities exists in an amount which cannot be stated in whole numbers unless a million be taken as the amount for comparison. If we even take the air of the underground railway tunnel, we find that the sulphurous acid amounts to only 3 times the amount, when the sulphur taste is pretty strong. This gives an indication of the limit of the senses in relation to this gas. It must be between the amount which exists in London and that which exists in the tunnel.

"Even taking oxygen alone, the amount of variation gives much higher numbers than we get with sulphur acids, but there is still an appearance of trifling when we speak of 20.99 and 20.79 or such numbers; still they do indicate atmospheres such as all sound sense of smell must distinguish. If we say 209,900 in a million and 207,900 in a million, we see the distinction clearly made with 2,000 units for the intermediate stages."

Carbonic acid. — "The variations in the amount of carbonic acid are less than in the case of oxygen. If we have the highest average amount of oxygen obtained on land 209,990, and the lowest not known to be effected by a town 209,470, we have a difference of 520 in a million; but if we treat similarly the carbonic acid, taking it where fields begin near Manchester to the top of Ben Nevis, or to the London parks, we have a similarity which is very remarkable. All are about 333 in a million. This has been referred to the fact that the method of oxygen analysis is less easy; but the results are so consistent that we may give up that idea. It is rather different when we go to close places; the amount of carbonic acid shows itself there more decidedly, perhaps because it does not diffuse so rapidly as the oxygen. The oxygen is, on the whole, not so practical an index to the condition of the air as the carbonic acid is." Some of the amounts of oxygen and of carbonic acid obtained follow: —

Oxygen.	Parts in a million
N. E. sea-shore and open heath, Scotland,	209,990
Top of hills, Scotland,	209,800
Suburb of Manchester in wet weather,	209,800
Manchester in fog and frost,	209,100
London, open places in summer,	209,500
London, average of 68 determinations,	208,850
Pit of theatre, 11.30 P.M.,	207,400
Metropolitan railway,	207,000
Court of Queen's Bench, Feb. 2, 1866,	206,500
In mines,	204,240 to 201,400
Worst specimen yet examined in a mine,	182,700
Carbonic acid.	
In mines — largest amount found in Cornwall,	25,000
" — average of 339 analyses,	7,850
Manchester — during fogs,	679

Carbonic Acid.	Parts in a million.
Manchester — ordinary weather,	403
" — where fields begin,	369
London — parks,	394
" — average of 68 determinations,	439
" — Metropolitan railway,	1,452
Glasgow — opener parts,	461
" — closer parts,	539

Ammonia. — The determinations of ammonia, free and albuminoid, have not been made with the absolute accuracy of the oxygen and carbonic acid determinations, and for the present are to be regarded as comparative. Some of the results were as follows, expressed in grains per ? cubic feet: —

	Free Ammonia.	Albuminoid Ammonia.
Inellan,	22.845	60.228
London (average of 18),	26.785	65.936
Glasgow (4),	34.169	133.264
Manchester (10),	53.582	116.544
Metropolitan Railway,	31.561	163.167
A midden,	146.911	181.524

Hydrochloric and Sulphuric Acids. — The average of a number of determinations in London, November, 1869, was 92.293 grains hydrochloric acid per ? cubic feet of air to 729.695 grains sulphuric acid per equal amount of air (1,000,000 cubic feet is probably far from the correct amount). A summary of comparative results obtained in certain places is as follows, the relation being to Blackpool taken as 100: —

	Hydrochloric Acid.	Sulphuric Acid.
Blackpool,	100	100
Buxton,	247	345
Dedsbury,	277	320
London,	320	361
Manchester,	369	549
St. Helens,	516	468
Metropolitan Railway,	974	1,554

Examination of Rain. — The results from the examination of rain are similar to, although not identical with, those obtained by washing the air. The results of a large number of determinations are to be found in R. Angus Smith's Sixth Annual Report, as Inspector under the Alkali Act. (*See also Journal of Scottish Meteorological Society, Jan.*, 1870.)

Amount of Carbonic Acid in the Air of Boston, Mass. — Determinations of the amount of carbonic acid in the air in various localities in the city of Boston, made by Mr. A. H. Pearson, Assistant in the Chemical Laboratory of the Massachusetts Institute of Technology, showed that the average amount, in streets and open places in the south-western part of the city, was 387 parts in a million, the amount varying from 257 to 500. In the Public Garden the average amount was 301 parts, and on the Back Bay lands, somewhat farther south, the average amount was 413 parts in a million. The highest amount found was 500, and the lowest 257. These determinations were made in the spring of 1870. A number of similar determinations were made in the winter of 1870–71, by Mr. Henry B. Hill, Assistant in the Laboratory of Harvard College, the experiments being made on the air in the college grounds. The amounts varied from 308 to 376 parts, the average amount being 337 parts in a million. Mr. Pearson also determined the amount of carbonic acid in the air of various (40) school-houses of the city of Boston, the experiments being performed in the early spring before artificial means of heating had been discontinued. He found amounts varying from 773 to 1,992 parts in a million, the average amount being 1,470 parts. — *Second Annual Report of the Massachusetts State Board of Health, Boston,* 1871.

ATOMIC THEORY.

Prof. Roscoe, in his opening address as President of the Chemical Section of the British Association, alluding to our imperfect knowledge of the fundamental laws which regulate chemical actions, brought forward the discussion which took place last year at the Chemical Society on the subject of the atomic theory, and says: "The president (Dr. Williamson) delivered a very interesting lecture, in which the existence of atoms was treated as 'the very life of chemistry.' Dr. Frankland, on the other hand, states that he cannot understand action at a distance between matter separated by a vacuous space; and, although generally granting that the atomic theory explains chemical facts, yet he is not to be considered as a blind believer in the theory, or as unwilling to renounce it if anything better presents itself. Sir B. C. Brodie and Dr. Odling both agree that the science of chemistry neither requires nor proves the atomic theory; whilst the former points out that the true basis of this science is to be sought in the investigation of the laws of gaseous combination or the study of the capacity of bodies for heat, rather than in committing ourselves to assertions incapable of proof by chemical means. Agreeing in the main myself with the opinions of the last chemists, and believing that we must well distinguish between fact and theory, I would remind you that Dalton's discovery of the laws of multiple and reciprocal proportions, — I use Dr. Odling's word, — as well as the differences in the power of hydrogen replacement in chlorhydric acid, water, ammonia, and marsh gas, are facts, whilst the explanation upon the assumption of atoms is, as far as chemistry is concerned, as yet advanced, a theory. If, however, the existence of atoms cannot be proved by chemical phenomena, we must remember that the assumption of the atomic theory explains chemical facts as the undulatory theory gives a clear view of the phenomena of light. Thus, for instance, one of the most important facts and relations of modern chemistry, which it appears difficult, if not impossible, to explain without the assumption of atoms, is that of isomerism. How, otherwise than by a different arrangement of the single constituent particles, are we to account for several distinct substances in which the proportions of carbon, hydrogen, and oxygen are the same? Why, for instance, should 48 parts by weight of carbon, 10 of hydrogen and 16 of oxygen united together, be capable of existing as 3 different chemical substances, unless we presuppose a different statical arrangement of the parts by which these differences in the deportment of the whole are rendered possible?

"If, then, it be true that chemistry cannot give us positive information as to whether matter is infinitely divisible, and therefore continuous, or consists of atoms, and is discontinuous, we are in some degree assisted in this inquiry by deductions from physical phenomena which have been recently pointed out by the genius of Sir William Thomson. He argues from four different classes of physical phenomena, and comes to the conclusion, not only that matter is discontinuous, and therefore that atoms and molecules do exist, but he even attempts to form an idea of the size of these molecules; and he states that in any ordinary liquid, transparent or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the hundred-millionth, and greater than the two-thousand-millionth of a centimetre. Or, to form a conception of this coarse-grainedness, imagine a raindrop, or globe of glass as large as a pea, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion, the magnified structure would be coarser grained than a heap of small shot, but probably less coarse grained than a heap of cricket-balls. There is, however, another class of physical considerations which render the existence of indivisible particles more than likely. I refer to the mechanical theory of gases by means of which — thanks to the labors of eminent English and German philosophers — all the physical properties of gases, their equal expansion by heat, the laws of diffusion, the laws of alteration of volume under pressure, can be shown to follow from the simple laws of mechanical motion. This theory, however, presupposes the existence of molecules, and in this direction again we find confirmation of the real existence of Dalton's atoms. Indeed, it has been proved that the average velocity with which the particles of oxygen, nitrogen, or common air are continually projected forward, amounts, at the ordinary atmospheric pressure, to 50,000 centimetres per second, whilst the average number of impacts of each of these molecules is 5,000 millions per second."

ORGANIC COMPOUNDS OF SILICON.

Combinations of Silicon with Alcoholic Radicals. — The results of the researches of Friedel and Crafts, on the ethers of silicic acid, and the discovery of a number of new bodies whose structure leads to the conclusion that the atomic weight of silicon is 28, and that the formula of silicic acid, SiO_2, were published some time since.* This atomic weight had already been assigned to silicon by Gaudin, and afterwards by Odling, from a consideration of the vapor-density of certain silicon compounds. Hitherto, however, conclusive proofs, based on purely chemical considerations, have been wanting, and many of the authorities on chemistry have adhered to the old formula. They say: —

---

* *Amer. Jour. Science,* XLIII. (1867), pp. 153 and 331.

"Our research was at first undertaken with a view to proving that the chemical properties of silicates can only be explained by adopting the new formula, and we have succeeded in obtaining bodies whose existence and mode of formation it is impossible to account for by any other theory. Such are the chlorhydrides and acetines derived from normal silicic ether, $Si(C_2H_5O)_4$, and at first we only studied the compounds which belong to the same type as the normal silicic ether; but the research led us further than we anticipated, and resulted in the discovery of the more complicated disilicic ethers, already described, whose structure throws some light on the rational formulæ of mineral silicates, and also of a remarkable class of bodies, in which the alcoholic radicals, ethyl, C_2H_5, and methyl, CH_3, are combined directly with the silicon, and not, as in the ethers, through the medium of oxygen. The present paper is devoted to the description of the latter bodies.

"The study of the compounds of silicon with alcoholic radicals, fortifies the conclusions already arrived at; it demonstrates the tetratomicity of silicon, and places it in the same group with titanium and carbon; and it leads, besides, to the discovery of a property of silicon, which allies that element with carbon far more closely than the equality of their atomicity and the similarities hitherto observed in the structure of their compounds. In fact, silicon has been found to possess the property of combining directly with carbon, or rather with hydrocarbons; and the resulting compounds are, in every respect, similar to simple hydrocarbons, susceptible like them of substitution of chlorine and bromine for hydrogen, and of acting as radicals in alcohols and ethers; consequently, silicon may take the place of carbon in a hydrocarbon, without modifying, essentially, its properties. It is easy to appreciate the importance of this result. Carbon is characterized by the property of combining with itself to build up groups of atoms, which have been compared to chains or nuclei, about which the atoms of hydrogen, oxygen, nitrogen, etc., found in organic bodies, group themselves, and it is especially this property of carbon which fits it to play the part of the element essential to the structure of organic compounds.

"It has been supposed that carbon alone had the property of combining with itself to form the nuclei of organic compounds, but it now appears that silicon shares with it this quality, and we are led to the opinion, that no element is unique in its properties, but that each has its near relatives among the others, as was indicated by Dumas, in dividing the elements into natural families, and as every new discovery daily tends to prove. It is remarkable, also, that analogies of this kind, which are independent in their nature of the atomicities of the elements, should occur especially between elements having the same atomicity, and the fact enhances the value of a classification of the elements, which is founded upon the consideration of their atomicities."

They further remark: —

"Only one point remains in which the analogy between silicon and carbon is incomplete. We have said that the most characteristic property of carbon in organic bodies is its power of combining directly with itself to form a complex molecule, capable of combining still further with other elements, as when 2 atoms of carbon, C_2, combine with 6 atoms of hydrogen to form the hydride of ethyl, C_2H_6. All the bodies, thus far discussed, belong to the simplest type of carbon compounds, as CH_4 and its analogue SiH_4; and in silicic ethyl 4 times C_2H_5 occupy the place of H_4; but Friedel and Landenburg* have lately completed the analogy and obtained the body, $Si_2(C_2H_5)_6$, belonging to the same type as Si_2H_6, and C_2H_6, showing that even in its quality of forming condensed compounds silicon resembles carbon." — *Amer. Jour. Science*, XLIX., *p.* 307 *et seq.*

Silico-Propionic Acid. — By the simultaneous action of zinc-ethyl and sodium upon ethyl-silicic monochlorhydrine, $SiCl,(OC_2H_5)_3$, Friedel and Landenburg have obtained a liquid boiling at 158.5° C., and having the formula $Si(C_2H_5)(OC_2H_5)_3$, which they term tri-basic silico-propionic ether. A concentrated solution of caustic potash does not set free in this compound the silicon in the form of silicic acid, SiO_2, but gives a product having the formula, $SiC_2H_5O_2H$, which, however, cannot be obtained in this way in a state of purity. By heating silico-propionic ether, at 180° C., in a closed tube, with chloride of acetyl, the authors obtained a mixture of acetic ether and a body having the formula $SiC_2H_5Cl_3$. By treating with water the part of this liquid which boils at from 90° to 110°, chlorhydric acid and a white gelatinous body are formed; this last is the hydrate of silico-propionic acid. When dried at 100°, the acid forms a white amorphous powder, greatly resembling silicic acid, but easily distinguished from it by its combustibility. When heated, it burns like tinder, disengaging combustible gases. The acid is insoluble in water, but dissolves in hot concentrated caustic potash, and is not precipitated from this solution by chlorhydric acid, but only by chloride of ammonium, like silicic acid, the residue after evaporation being unchanged silico-propionic acid. The new substance appears, therefore, to be a weak acid, analogous to silicic acid, and presents the first known case of a silicic acid containing carbon. Its formula shows that it contains the group, SiO_2H, which may be termed *silicoxyl*, and which is the analogue of carboxyl, CO_2H. It is easy to see, alse, that it forms one term of a group of homologous acids. — *Amer. Jour. Science, from the Comptes Rendus.*

Natural Organic Compounds of Silicon. — At the reading before the French Academy of Friedel and Landenburg's paper, on *silico-propionic acid,* Dumas remarked how readily one might mistake silica, containing a greater or less amount of the new organic acid, for pure silica, and suggested whether silicious compounds occurring in nature, and containing organic matter, might not actually hold the same in chemical combination. Thenard, in the same connection, referred to researches recently made by him on silico-organic acids, of which he has prepared several, varying in their percentage of silica from 7.5 to 24 per cent. The process of preparing these compounds is an indirect one. Ulmic acid is treated with ammonia, and a nitrogenous acid formed which possesses the property of readily combining with silica to produce a compound soluble in caustic alkali, from which it can again be isolated unchanged by the addition of a mineral acid. The quantity of silicon entering into these compounds seems to be proportional to the amount of nitrogen originally held in combination. The author is led to believe that there always exist in soils these silico-organic acids, and that they play a very important part in the nutrition of plants. He regards the action as different from the property already noted by Verdeil and Rislher, by which sugar and other non-nitrogenous organic bodies dissolve up small quantities of silica; nor does he confound the silicated organic compounds (*organo-silicatées*) with the compounds described by Friedel, in which silicon plays the part of carbon. Still, we have no right to assert that the former may not, in nature, lead to the latter, and the author thus explains the origin of the silicon which attacks a platinum crucible when used for the calcination of rich soils. — *Comptes Rendus.*

---

* "Comptes Rendus," LXVIII., 1869, p. 920.

Chemical Geogony of Silica. — In the American "Gas-Light Journal," for September 2, 1870, Professor Henry Wurtz thus remarks on the papers of Friedel and Thenard: "We have thus demonstrated at once a theory not only of new relations of plant decay to plant nutrition, but also of the far broader subject of the transformations and migrations of silica throughout all past geological ages, and of the continual and (as the writer has long believed) *sole* agency of *life* in these, as in the past and present migrations of carbon."

Prof. Wurtz presented a preliminary paper "On the Chemical Geogony of Silica," to the New York Lyceum of Natural History, in which he says: —

"The importance of the function of soluble and hydrated forms of silica in mineral fertilizers, like green sand, has been underrated. Silicic acid, though so minute an ingredient in actual animal nutrition, is indirectly as essential to animal life as even carbonic acid." By the application to the past history of silicic acid of the same process employed by the author in tracing out the anterior stages of the chemical changes now going on in the case of carbon and oxygen (see various papers in the Proceedings of the American Association), Prof. Wurtz believes that his studies have unmistakably tended toward the conclusion that silicic acid, *as such*, that is, in isolated forms, *appertains, in origin at least, altogether to the vegetable kingdom*, and that the tendency of chemical investigation and discovery is to confirm this conclusion. He presented to the Lyceum a diagram illustrating his view of the changes undergone (see also the "American Chemist" for

December, 1870), from the earliest times when the silica existed in the state of igneous silicates, to the present time.

SECONDARY PRODUCTS OBTAINED IN THE MANUFACTURE OF CHLORAL.

Krämer ("Ber. deutsch. chem. Gesellschaft," III, pp. 257-262) has studied the other products of the action of chlorine upon alcohol, the existence of a large quantity of ethylic chloride having been shown by Hoffman. As the ethylic chloride was in contact with an excess of chlorine, it was natural to expect to find in the less volatile oily products the whole series of chlorinated ethylic chlorides described by Regnault; and experiments showed that several of these products were present.

The most volatile product, boiling at 60°, proved to be chlorinated chlorethyl, or chlorethylidene, $C_2H_4Cl_2$, identical with the chlorethylidene prepared from aldehyde. A liquid boiling at 85°, proved to be ethylene-dichloride, the formation of which by the action of chlorine upon ethylic chloride had not before been observed. The next product was chlorinated ethylene-dichloride, C_2H_3Cl,Cl_2 boiling at 150°; and the last, bichlorinated ethylene, $C_2H_2Cl_2$ boiling at 37°. Other chlorinated products were also observed, but not yet studied. To prove the identity of the chlorethylidene obtained in this manner with that obtained from aldehyde by the action of pentachloride of phosphorus, Krämer heated a portion of it with alcoholic ammonia to 160° for 12 hours. In this manner an oily base boiling at 180°–182°, and having the characteristic odor of collidine, $C_8H_{11}N$, was obtained.

This base has already been formed from aldehyde-ammonia, by Baeyer, and found to be identical with that obtained by Anderson from animal oil. — *Amer. Jour. Science, July,* 1870, *p.* 111.

UTILIZATION OF THE SECONDARY PRODUCTS OBTAINED IN THE MANUFACTURE OF CHLORAL.

Dr. A. W. Hoffman ("Comptes Rendus," April 25, 1870, p. 906) has examined a mixture of secondary products obtained during the manufacture of chloral, and condensed during cold weather. The liquid began to boil at 17°–18°, the temperature rising slowly to 30°–31°, where it remained constant a short time, and then rising again to 50°, when nearly all distilled over. The most volatile portions were mixed with 3 times their volume of alcohol saturated at 0° with ammonia, and heated in a water-bath for an hour. The liquid was then filtered to separate crystals of sal-ammoniac, and the alcoholic ammonia and chlorinated ethylic chlorides distilled off. The mass of chlorhydrates of ethyl-ammonias remaining were decomposed with caustic soda, and the separated liquid alkalies dehydrated by caustic soda, and finally distilled. In this manner 5 litres of the secondary products operated upon gave 1½ litres of a mixture of anhydrous ethylamines. These *could be separated* from each other by means of oxalic ether, in the manner already pointed out by Hoffman. The results of this investigation are interesting from the prospect which they afford of obtaining the ethyl-ammonias as an article of commerce, at a reasonable price, and in comparative abundance. — *Amer. Jour. Science, July*, 1870.

CHEMICAL BREVITIES.

Preparation of Anthracene. — Dr. J. Gessert. — That portion of the distillation of coal tar commonly called green grease, and used as wagon and cart grease, is, according to the author, the material of coal tar which contains anthracene, and consists chiefly of a heavy oil, napthaline, and about 20 per cent. of anthracene, which, however, is contained in coal tar only to the amount of from three-fourths to 1 per cent. This semi-fluid grease is first placed in a centrifugal machine, in order to expel mechanically as much as possible of the oil; the residue is heated to 40° and pressed, preferably between hot plates. The cake thus obtained (crude anthracene, containing 60 per cent. of that substance) is purified by boiling with light tar oil, (coal-tar naphtha) or with petroleum naphtha. The pasty mass is again placed in the centrifugal machine to remove the last traces of heavy oil, and the material is next submitted to sublimation. In order to test the "green grease" for the quantity of anthracene, from 5 to 10 grams of that substance are taken, placed between folds of filtering paper, and pressed between hot plates; the remainder of the substance is repeatedly boiled with alcohol, washed with cold alcohol upon a filter, dried and weighed. The fusion point of the mass should be as near as possible 210°. The author says that sulphide of carbon is not well suited for the preparation of anthracene, on account of the too ready solubility of anthracene in that fluid. 100 parts of alcohol dissolve, when cold, 0.6 part of anthracene; 100 parts of cold benzole dissolve 0.9 part anthracene; 100 parts sulphide of carbon dissolve 1.7 part anthracene. — *Chemical News.*

Preparation of Bromide of Sodium. — According to M. Castelhaz ("Comptes Rendus") the best plan is to prepare, first, bromide of ammonium, by causing bromine to fall, drop by drop, into dilute pure liquid ammonia contained in a series of Wolff's bottles, in order thus to prevent the loss otherwise inevitably resulting from the volatilization of the products formed by the great heat disengaged by the union of the bromine and ammonia. The liquids, after saturation, are evaporated in a cast-iron retort, to which an earthen-ware receiver is fastened, wherein are collected the vapor of water, any excess of ammonia and some bromide of ammonium, which is accidentally carried over. The bromide of ammonium thus obtained is converted into bromide of sodium, by being mixed with pure carbonate of sodium, and the application of sufficient heat to volatilize and sublime the carbonate of ammonium formed by the reaction. This mode of preparation yields, after re-solution of the bromide in water and evaporation similar as in the case of chloride of sodium, perfectly pure and anhydrous bromide of sodium. — *Chemical News.*

Preparation of Bromhydric Acid. — Messrs. Champion and Pellet prepare bromhydric acid in concentrated solution, by slowly distilling bromine (at a temperature of 65° C.) from a retort, the bent neck of which dips into a second retort containing paraffine, kept at a temperature of 180° C. The bromhydric acid formed is passed over bits of moistened phosphorus, to remove the last traces of bromine, and then passed into the liquid to be saturated, which is kept cool by ice. The solution of bromhydric acid thus obtained, saturated at 0° C., has a density of 1.78, and contains 1.46 gram of real acid in 1 c. c. of the solution. — *Bull. Soc. Chim.*

Manufacture of Iodine. — About 40 kilos. of iodine are daily produced at Tarapaca, Peru, from the mother-liquors obtained in the refining of the crude nitrate of sodium. The process used was invented by a Frenchman named Thiercelin, and is as follows: To the mother-liquors is carefully added a mixture of sulphurous acid and bisulphite of sodium, whereby all the iodine present is precipitated as such in the state of a black powder; it is freed from the adhering liquid by collecting it on a *sand filter* consisting of several layers of clean sand, the grains decreasing in size from below upwards. When dry, all the iodine except a thin layer is removed, and purified by sublimation. It has been lately found more advantageous to use nitrous acid obtained as nitrite of potassium by igniting 1 part of charcoal with 5 parts of nitrate of potassium; the nitrite yields, when mixed with the mother-liquor, a precipitate containing some 80 per cent. of iodine.

Preparation of Strontium. — M. Franz prepares strontium by subjecting an amalgam of it with mercury to a low red heat in a current of dry hydrogen gas. He uses for this purpose an iron crucible. At the end of the operation the strontium is in the state of a fused mass, and may be readily removed from the crucible. The strontium amalgam is prepared by heating to about 90° C. a sodium amalgam (250 grams of sodium to 1000 grams of mercury) with a concentrated solution of chloride of strontium. This amalgum must be washed and dried rapidly, as it changes much more rapidly in the air than either sodium or barium amalgam. Strontium is a yellowish, very malleable metal. It oxidizes rapidly in the air, and burns with a bright light, throwing off sparks. It melts at a low red heat, and does not volatilize at a bright red heat. Its density is 2.4. — *Jour. für prakt. Chemie.*

Crystalline Alloy of Zinc and Calcium. — The production of a crystalline alloy of zinc and calcium has been observed in the preparation of calcium by the process of M. Caron, in which an excess of zinc was employed. It contains about 95 per cent. of zinc, and 5 per cent. of calcium, and corresponds to the formula Zn_2Ca. The crystals are small octahedra with square bases. They are acted upon by water, with liberation of hydrogen. — *Chemical News, from Poggendorf's Annalen.*

Double Sulphide of Potassium and Iron. — By heating an intimate mixture of 5 parts sulphur, 5 parts carbonate of potassium, and 1 part fine iron-filings, C. Preiss ("Pogg. Annalen") has succeeded in forming a double sulphide of potassium and iron which crystallizes in red needles, has a metallic lustre, and resembles in appearance permanganate of potassium. Its formula is KS,Fe_2S_3. The same compound has been obtained independently by R. Schneider, who also has formed by the replacement of iron with bismuth an analogous compound, the formula of which is KS,Bi_2S_3. — *Chemical News.*

Preservation of Thallium. — According to Dr. Böttger, thallium may be best preserved from oxidation by being kept under pure distilled water, freed from air by long boiling, and cooled in a closed flask. A specimen thus treated has preserved its silvery metallic lustre unaltered for three years. — *Dingler's Polytechn. Jour.*

Alloys of Manganese. — At the Liverpool meeting of the British Association, Mr. J. Fenwick Allen displayed a series of alloys of manganese with various other metals. They were prepared by first forming an alloy of copper and manganese by the reduction of a mixture of carbonate of manganese and oxide of copper, and producing, from this simple alloy, compound alloys with other metals. The series of specimens was as follows: (1) Manganese and copper in various proportions, from 35 to 5 per cent. of iron, as ingot, sheet, and wire; (2) copper, zinc, and manganese, also, in different proportions, and in a variety of applications; (3) copper, zinc, manganese, and tin as ingots, and as bearings for machinery; (4) copper, manganese, and tin in several different proportions as bars; (5) copper, manganese, and lead. A simple alloy of copper (75 per cent.) and manganese (25 per cent.) was found to be very hard and very brittle when hot; but when cold, although still hard, it rolled with ease, and was highly elastic. Certain mixtures of copper, zinc, and manganese possess the advantage over both German silver and yellow metal, that whereas the one will roll only cold, and the other only hot, the manganese alloy rolls from hot to cold. The intense heat required to reduce the copper and manganese was furnished by an application of the Siemens' furnace, and the hope is expressed that these alloys will not play an unimportant part in the manufactures of the day.

Iron and Hydrogen. — Dr. Klein states that the iron obtained by electrolysis is not, as has often been thought, pure iron, but a compound or mixture of iron and hydrogen, which, when heated to redness, gives off an enormous amount of hydrogen, and becomes, while greatly increasing in bulk, a silver-white, very malleable metal, decomposing water readily at a temperature below its boiling-point, and oxidizing with great rapidity. — *Les Mondes.*

Peruvian Bismuth. — This article now in commerce contains, according to Barth ("Pogg. Annalen"): —

Bismuth,	93.372
Antimony (trace of tin),	4.570
Copper (little iron),	2.058
	100.000

Hence it differs from the Saxon bismuth, principally by the absence of arsenic and sulphur. — *Chemical News.*

Alloy of Ammonium and Bismuth. — Dr. Gallatin states that he has succeeded in forming an alloy of ammonium and bismuth by melting the latter, and adding sodium to form an alloy of bismuth and sodium, and then covering the alloy with chloride of ammonium. The mass swells, becomes pasty, and congeals. Under water, nascent hydrogen and ammonia gas are evolved, the latter being absorbed by the water. —*Philosophical Magazine, July,* 1869, *p.* 58.

Fusing Irodosmine. — Moses G. Farmer, of Boston, has fused the native irodosmine by placing the natural grains in a groove in charcoal, and subjecting them to the action of a current of voltaic electricity from 60 large Bunsen cells, using large platinum wires to make contact with the ends of the groove. He obtained, in this manner, bars of perfectly compact metal, brittle, and very hard. The operation was anything but pleasant, on account of the intense light emitted, and the fumes of osmic acid which attacked the eyes and nostrils, producing the phenomena of *rose or hay fever*, and sunburning the face. Mr. Farmer estimates the temperature of fusion at about 10,000° F.

The object of the experiment was to prepare a bar of the alloy for the purpose of electric illumination. On rendering it luminous by an electric current, he found that when near the melting-point 1 square inch of surface evolved light equal to 2,000 candles, and threw shadows in broad daylight at noon and produced excellent photographs. The same battery converted solid bichloride of iridium into fused metal as soft and ductile as platinum. — *Amer. Chemist,* I. 27.

Chloride of Gold. — Debray, in the "Comptes Rendus," recalling the fact that sesquichloride of gold is decomposed at a temperature of 200° into protochloride and free chlorine, and at a still higher temperature into metallic gold and chlorine, states that it is, however, possible to sublime the sesquichloride, and obtain it in crystals by performing the operation in chlorine gas. This is accomplished by passing a current of chlorine over metallic gold heated in a glass tube to 300° C. Below that temperature the gold is covered with a coating of chloride, but volatilization does not begin until that temperature is reached. The sesquichloride condenses in long needles at some distance from the heated portion of the tube.

In this connection might be mentioned a recent determination of the vapor density of quinquichloride of phosphorus, a problem not hitherto solved on account of the decomposition of this compound into terchloride and free chlorine. By operating with an excess of the terchloride the vapor density has been found to agree with theory so that quinquichloride of phosphorus no longer forms even an apparent exception to general law in regard to the *product volume.*

Magnesium as a Reducing Agent. — Dr. Böttger recommends the use of magnesium powder, as it occurs in the market, for the reduction of *certain* metallic salts, especially chlorides. At the ordinary temperature, a solution of bichloride of platinum is immediately decomposed, the platinum being thrown down as the finest platinum-black. Chloride of gold deposits metallic gold in a similar manner, and even zinc may be thus obtained from a solution of its chloride. — *Dingler's Polytech. Jour.*

Sodium as a Flux for Minerals. — *Dr. Schonn.* — A steel crucible 1½ inches deep, and the same in diameter, is heated over a lamp; into this are projected a few pieces of metallic sodium, and afterwards the finely divided and dry mineral is added. The crucible is then covered and heated red-hot. As soon as the reaction is finished, the contents of the crucible are allowed to cool, and water is cautiously added sufficient for the purposes of filtration. The fused mass is then thrown upon a filter and thoroughly washed. In the filtrate will be found the electro-negative constituents of the mineral, combined with the sodium, such as sulphur, cyanogen, chlorine, chromic acid, silica, molybdic and tungstic acids, and such oxides as are soluble in soda-lye. On the filter will be found the metals and their oxides, also the lower oxides of titanium, molybdenum, tungsten, and possibly silica and alumina. The contents of the filter and the filtrate can be treated according to the order of analysis. — *Chemical News.*

Action of Sulphur on Gold. — William Skey, of the Geological Survey of New Zealand, having investigated the reported loss of gold during the process of extraction at the Thames gold-fields, finds that numerous samples of bright, clean-looking gold, of all degrees of fineness, refuse to amalgamate on any part of their natural surfaces, and that in such cases sulphur is always present. He finds, also, that gold exposed to a moist atmosphere of sulphuretted hydrogen, or to sulphide of ammonium, absorbs sulphur without change in appearance, and that after such treatment it refuses to amalgamate. The gold may be restored to its original condition by the action of chromic or nitric acids, and by roasting in the air. A large portion of the surface of the gold being thus naturally sulphurized, the author considers the loss as resulting from the failure to amalgamate of those particles which escape abrasion in the milling process. — *Chemical News.*

Influence of Ozone on the Explosibility of Picrate of Potassium. — M. Houzseau, whose researches on ozone are well known, has made some experiments on the action of this substance on picrates. He prepared a flask of ozone, into which he introduced 5 decigrams of picrate of potassium; an explosion immediately ensued, shattering the vessel to fragments by its violence. He then operated with a mixture of air and ozone (in which the ozonometer marked 500 millimeters), and, on adding the picrate, the explosion again occurred with the same intensity. Proceeding by degrees he arrived at the conclusion that picrate of potassium is decomposed when the ozonometer marks 45 millimeters.—*Druggists' Circular.*

Action of Ozone on Explosive Bodies. — According to the experiments of M. Jouglet, nitro-glycerine will explode in a vessel containing ozone; the same is true of dynamite, iodide of nitrogen, chloride of nitrogen, and other similar compounds. — *Comptes Rendus.*

Action of Chlorine on Metallic Sodium. — Wanklyn finds that when chlorine gas is passed over metallic sodium, even when the metal is in a state of fusion, no chemical action takes place. — *Chemical News, No.* 271.

Purification of Bisulphide of Carbon. — Cloez purifies the ordinary bisulphide of carbon of commerce by treating with half a per cent. of corrosive sublimate, and allowing it to remain in contact with it with occasional shaking for 24 hours. The clear liquid is then decanted, mixed with 2 per cent. by weight of some inodorous fat, and distilled at a low temperature.

Solid Sulphide of Carbon.—Herr v. Wartha has obtained sulphide of carbon in the solid state in the form of cauliflower-like masses, by rapid evaporation under the influence of a quick current of air, in the same manner as solid carbonic acid is formed as a substance resembling snow by the extreme cold caused by the rapid evaporation of the liquid acid. If the evaporation of the sulphide of carbon takes place under water, the water is changed to ice, and the whole assumes a temperature of —13° C. (+9° F.), which is the same temperature at which the solid sulphide of carbon melts. — *Academy.*

Cane Sugar in the Madder Root. — Stein has proved the presence of cane sugar in the madder by treating the root with 80 per cent. alcohol, and adding absolute alcohol to the residue after the distillation of three-quarters of the liquid in a current of carbonic acid; there is precipitated a black syrupy mass, and the alcohol liquid separated from this mass deposits crystals of sugar, the amount of which may be increased by the addition of ether. The composition, the crystalline form, and the rotating power of this sugar when purified, are identical with those of cane sugar. There is also contained in the root an uncrystallizable sugar. — *Jour. für prak. Chemie.*

Combination of Hydrogen and Sulphur. — It is a mistake to suppose that hydrogen does not combine directly with sulphur. When a stream of hydrogen is passed over boiling sulphur, sulphuretted hydrogen is produced in abundance, as may be readily proved by passing the gas into a solution of copper or of lead. — *Ber. deutsch. chem. Ges.*

Formation of Sulphuretted Hydrogen. — When a current of steam is passed over boiling sulphur, the odor of sulphuretted hydrogen becomes immediately perceptible, and the water which is condensed has an acid reaction from the presence of pentathionic acid; to distinguish this acid from hyposulphurous (dithionic) acid, a solution of chromic acid may be employed. This reagent produces a brown coloration or precipitate with dithionic acid, while with pentathionic acid no coloration is produced. The reaction may be expressed as follows: —

$$10S + 6H_2O = H_2S_5O_6 + 5H_2S.$$

— *Bull. Soc. Chem. June,* 1870.

Trinkerite, a newly discovered Fossil Resin.—Dr. G. T. Tschermak. The author states that the resin alluded to is found in compact masses in the braunkohle formation, near Carpano and Albona, in Istria. The resin is brittle; its color varies from hyacinth red to chestnut brown. The mineral exhibits a fatty gloss and is transparent; its fracture is plano-conchoidal; its specific gravity is 1.025; it becomes highly electric when rubbed, and gives off, on being gently heated and on being pulverized, an aromatic pleasant odor; its melting-point varies from 168° to 180°. When fused the substance gives off a nasty, pungent smell, and when the molten mass begins to boil, vapors are given off which, carried into solutions of lead or copper salts, cause a black precipitate therein. This resin was chemically investigated by Professor Hlasiwetz, the result of whose research is as follows: The substance is hardly soluble in alcohol or ether, but is perfectly soluble in boiling benzol; heated in a retort it melts, begins to boil, then gives off sulphuretted hydrogen gas and yields an oily distillate. The elementary analysis led to the following percentage results: carbon, 81.1, hydrogen, 11.2, sulphur, 4.7, oxygen, 3.0; no ash. When treated with fusing caustic potash, the resin is oxidized, but the products of this reaction did not yield anything specific. The resin appears to belong to the substances akin to copal; but the fact that it contains sulphur is peculiar, since as yet no other fossil resin containing sulphur is known except the tasmanite of Dr. Church ("Phil. Mag." xxxviii., 1864, p. 465). Tasmanite is, however, absolutely insoluble in benzol. — *Chemical News, from the Jahrbuch der K. K. Geologischen Reichsanstalt, No.* 2, 1870.

New Volumetric Method for the Estimation of Copper. — This method, proposed by Weil, is based upon the following facts: (1.) That in the pressure of an excess of free chlorhydric acid and at the temperature of boiling, the least trace of bichloride of copper communicates a very marked yellowish-green tint to the solution. The greater the excess of chlorhydric acid the more intense the coloration: (2.) That at this temperature protochloride of tin instantly reduces the bichloride of copper to protochloride, which is colorless. The moment at which the reaction is finished is indicated by the complete decoloration of the liquid. When the liquor to be titrated contains iron as well as copper, the amount of protochloride of tin indicates the sum of the iron and copper. In this case the iron is titrated in a separate portion of the assay in sulphuric acid solution with permanganate of potassium after precipitation of the copper by means of zinc and platinum. The solution of protochloride of tin is standardized with pure copper and preserved from oxidation by a layer of petroleum. — *Comptes Rendus, May* 2, 1870, *p*. 997.

Detection of Arsenic in Tartar Emetic. — To as much tartar emetic as can be held on the point of a good-sized knife, is added twice as much pure protochloride of tin, and the mixture introduced into a wide test-tube; 4 or 5 c. c. of pure chlorhydric acid (containing 25 per. cent real acid) are added; and subsequently 2 or 3 c. c. pure concentrated sulphuric acid. If the adding of the sulphuric acid does not heat the contents of the tube sufficiently, the mixture should be warmed over the lamp. If arsenic be present the fluid becomes yellowish, then brown, and finally a brown flocculent precipitate of metallic arsenic appears.—*Dingler's Polytech. Jour.*

Detection of Gold. — W. Skey, analyst to the Geological Survey of New Zealand, proposes to treat the *roasted* ore with a solution of iodine (in alcohol) or of bromine (in water). To the resulting solution, after concentration, may be applied the ordinary tests for gold. If Swedish filtering-paper be dipped into such a solution containing gold and subsequently incinerated, the ash will have a purple color. The identification of gold by the combustion of the salts with filtering-paper, it is suggested by Mr. Skey, seems to promise a rapid method of estimating this metal by the aid of a series of prepared test-papers representing gold in different degrees of dilution.—*Chemical News.*

Reagent for Strychnia. — When strychnia is well moistened with concentrated sulphuric acid, there ensues, on addition of proto-sesquioxide of cerium, a fine, blue coloration, turning to cherry-red. As small a quantity as 0.000001 grain can thus be detected. Other alkaloids treated in the same way give, — brucine, a yellow coloration; morphine, brown; narcotine, first brown, then cherry-red; quinine, pale yellow; cinchonine remains colorless.—*Sonnenschein.* — *Ber. deutsch. chem. Ges., No.* 12, 1870.

Detection of Logwood Color in Wines. — J. Lapeyrère uses for the detection of logwood in wines slips of fine filter-paper (Swedish preferred) soaked in an aqueous solution of neutral acetate of copper; one of these slips is dipped into the suspected wine and then rapidly and carefully dried. The color of the paper after drying should be gray or grayish-red; if, however, logwood be present, the color will be of a distinct sky-blue.

Estimation of Grape Sugar. — *Karl Knapp.* — The author proposes a method for the determination of grape sugar, based on the fact that this substance reduces metallic mercury of a solution of mercuric cyanide. As determined by experiment, 400 milligrams of mercuric cyanide are reduced by 100 milligrams of grape sugar. The standard solution is prepared by dissolving 10 grains dry mercuric cyanide in water, adding 100 c. c. of a solution of caustic soda of 1.145 sp. gr., and diluting to 1,000 c. c. Of this solution, 40 c. c. (an amount corresponding to 100 milligrams pure grape sugar) is heated to boiling in a porcelain dish, and the solution of sugar under examination is then added until the mercury is completely reduced, the end of the reaction being marked by the failure of sulphuretted hydrogen to blacken a piece of fine filter-paper moistened with a drop of the solution. This test is superior to Fehling's, inasmuch as the standard solution is easily prepared and keeps well; less time is also required for the determination, and foreign substances which hide the color of the cuprous oxide do not interfere with the reduction of the mercury. — *Annalen d. Chem. und Pharm.*

Phosphoric Acid from Iron Furnace Slag. — When pig iron containing phosphorus is converted into wrought iron, the phosphorus is eliminated, and is found in the furnace cinder, as phosphate of iron. The amount of phosphorus varies, of course, with the pig used, that from the Cleveland pig containing from 3 to 7 per cent. of phosphoric acid. Mr. James Hargreaves proposes to utilize this phosphoric acid for fertilizing purposes. The cinder is melted with lime and magnesia, and then roasted. The protoxide of iron is converted into a higher oxide, slowly soluble in cold dilute chlorhydric acid, while the phosphate of calcium dissolves readily in this reagent. The cinder may be dissolved in chlorhydric acid directly, and the acid solution treated with lime or chloride of calcium, sufficient to enter into combination with the whole of the phosphoric acid. The mixture is then evaporated to dryness and heated to redness to render the peroxide of iron insoluble in chlorhydric acid, and the dry residue treated with acid as in the preceding method. The chlorhydric acid used is utilized as described on page 169. Mr. Hargreaves estimates that 130,000 tons of phosphoric acid are wasted annually in Great Britain in the iron cinder from the furnaces.

Use of Sulphurous Acid in Bleaching Sugar. — A. Seyferth makes use of sulphurous acid for bleaching sugar by mixing in a vacuum pan 100 parts of a concentrated solution of sugar(28°–42° Beaumé), with from 3 to 15 parts of a solution of sulphurous acid containing not more than from 1 to 1¼ per cent. of the acid. The mixture is then concentrated to the proper strength, the whole of the sulphurous acid escaping. The sugar solution thus treated loses completely the peculiar taste generally noticeable in beet-root sugar. — *Ber. deutsch. chem. Ges.*

Condensation of the Nitrous Vapors in the Manufacture of Sulphuric Acid. — *R. Hilman and P. Hart.* — The vapors are condensed by means of water, wherein lime or magnesia is suspended, and the liquid obtained is either (1) evaporated to dryness and the residue ignited, or (2) heated to the boiling-point with addition of chlorhydric or sulphuric acid; or (3) evaporated to dryness and the residue mixed with the residues of the chlorine manufacture and heated to a gentle red heat; in either case, the nitrous vapors thus obtained are used again in the chambers.

Dextrine Insoluble in Water. — *M. Musculus.* — The author of this paper has obtained a variety of dextrine insoluble in water by the action of glacial acetic acid on starch. This variety of dextrine is composed of particles of starch which have undergone chemical change with losing their organized structure. These particles are rendered soluble by being heated with water at 100° C. for several hours. A similar product may be obtained by boiling the starch with water acidulated with sulphuric acid. This variety consists of little granules, 0.010 to 0.030 m. m. in diameter, insoluble in cold water, but dissolved without subsequent separation by water at the temperature of 50° C. — *Comptes Rendus.*

Discrimination of Fibres in Mixed Fabrics. — Mr. Spiller treats the fabric with strong chlorhydric acid, which dissolves silk completely and immediately, without appreciably affecting any woollen or lignine fibres with which the silk may have been interwoven. The residual fabric or loose filaments may then be washed and collected, and will be usually without color. A warm aqueous solution of picric acid then applied instantly imparts a warm yellow tint to wool, but does not in the least affect cotton, linen, jute, or china-grass. In the examination of ribbons and some other stiffened goods, it is often necessary to immerse them for a few minutes in boiling water to dissolve out the starch or size prior to applying the chlorhydric acid test; for, by this simple expedient, the results are rendered much more decisive.

The mucilaginous solution of silk in chlorhydric acid cannot be evaporated even over a water-bath, without becoming somewhat carbonized. The brownish uncrystallizable residue left on evaporation reacts acid on test-paper, and has, when warm, an odor suggestive of caramel. If to the residue which remains after evaporating the silk solution under a bell-jar over slaked lime, ammonia be added in excess, a clear solution results, which may find some application in photography; for, when this liquid is evaporated, there is left a brown saline mass of rough astringent flavor, which, when mixed with an aqueous solution of nitrate of silver, gives a peculiar flocculent form of chloride of silver, which is no longer curdy, and which is much more rapidly affected by light than the ordinary chloride. These properties enable the silk compounds to be usefully employed in the production of "matt-paper" prints, and direct solar-camera enlargements. — *J. Spiller before British Association*, 1870.

Phenyl Brown, the so-called Phénicienne. — MM. Bolley and Hummel. — This substance, also called *rothéine*, is not to be confounded with the brown coloring matter made by Messrs. Roberts, Dale, & Co., at Manchester. The phenyl brown of M. Roth's invention is a substance which, without the use of any mordant, yields, upon silk and woollen fabrics, fast colors. Since it has been alleged that the brown dye alluded to is possessed of explosive properties, the authors have investigated the manufacture, and the reactions which take place during the process. The authors find that, when a mixture of nitric and sulphuric acids (1 part of the former of a sp. gr. of 1.35, and 2 of the latter, concentrated) are made to act upon phenol, two different products are always produced, — one of these a solid substance, sometimes like thick tar, sometimes grainy; and a deep red-colored liquid. When this latter is poured into cold water, a pulverulent brown-colored substance is precipitated, which possesses all the characteristic properties of commercial phénicienne. The result of the researches arrived at by the authors is, that the phénicienne is a compound mixture of binitro-phenol, and a peculiar amorphous substance, which has some likeness to the ulmic and humic substances, but the precise nature of which has not been ascertained. — *Moniteur Scientifique.*

Naphthaline Red. — This coloring matter is called in England *Magdala Red*, in honor of Lord Napier, the hero of Abyssinia, in imitation of the French names of Magenta and Solferino for aniline colors. It is prepared by the action of nitrous acid on naphthylamine, and is manufactured in large quantities in France and England. It is a dark brown powder soluble with deep red color in boiling alcohol, only slightly soluble in cold water, but largely in hot water; not soluble in ether. The solution in alcohol is highly fluorescent, which reaction affords, according to Hoffman, a method of distinguishing it from aniline red. In depth of color it is said to be equal to aniline, while it is superior to that dye in permanency, but it loses lustre on dark tints, and hence its use is limited to light shades. — *Druggists' Circular.*

Soluble Garnet. — The "Engineer" states that the new dye known as soluble garnet seems to be coming more largely into use on the continent, and as the colors produced with it are exceedingly brilliant, similar to those obtained with archil, but much more stable when exposed to light and air, the garnet dye is likely to become a great favorite. The dye was first prepared by Casthelaz of Paris, and is the ammonium salt of isopurpuric acid, which is formed by the action of a metallic cyanide upon picric acid. It is not prepared from the pure crystallized, but from the inferior kind of picric acid, and is probably designed to replace the archil in many cases, in imparting to wool all shades from garnet to chestnut-brown. It may be readily combined with other pigments, so that a number of different colors may be obtained. According to Casthelaz, the dyeing of silk or wool is affected by the addition of an organic acid to the bath, for instance, acetic or tartaric acid, mineral acids being excluded. The dye-bath for silk should be cold or tepid in the beginning. Different shades in red or brown are thus obtained that are dependent upon the concentration of the bath, the nature of the mordant, and the time of the operation. — *Nature, Aug.* 4, 1870.

Bleaching of Fixed Fatty Oils. — *M. Dieterich.* — Into a wooden tub, provided with a properly constructed tap at the bottom, are poured 30 litres of water, wherein 1 kilo. of permanganate of potassium is dissolved. To this mixture is added 50 litres of the oil to be bleached, and the fluids well stirred up for about 2 days; at the end of that time 20 litres of boiling water and 5 kilos. of commercial chlorhydric acid are added; the liquid is again well stirred up, and, after 2 more days, the acid liquor is run off by means of the tap, and, having been removed, the oil is repeatedly washed with boiling water, until all the acid is removed from it. — *Moniteur Scientifique.*

Oxide of Zinc as a Mordant. — Biot and Thirault have patented a method for the use of oxide of zinc as a mordant for the dyeing of cotton with aniline blue, and for fixing iodine green on wool. G. Merz, of Chemnitz, uses oxide of tin as a mordant for fixing iodine green on cotton and wool. — *Deutsche Industrie Zeitung.*

New Mordant. — For fixing colors in dyeing and printing, M. Kipping, of Manchester, makes use of the property of gelatine and gum of becoming insoluble in water after the addition of solution of a chromate. The coloring matters are mixed with gelatine or gum and some chromate, as the bichromate of potassium. Commercial gelatine is dissolved in water and one-sixth its weight of bichromate is added to the solution, the operation being performed in a rather dark room; the coloring matter is next added to the mixture. The strength of the solution of gelatine depends on the consistency of the color to be employed.

After printing, the fabric is exposed freely to the light. — *Deutsche Industrie Zeitung.*

Artificial Fruit Odors. — A strong alcoholic solution of shellac, mixed with 20 times its volume of 49 per cent. solution of bisilicate of sodium, gave, in a fortnight, a strong smell of ripe pears, changing in a month to that of turpentine. A strong, aqueous solution of non-crystalline sugars mixed with 5 volumes of the same silicate solution, gave, in a few days, an odor of apples, which still persists after some months.

Caseine and bisilicate of sodium gave a faint ammoniacal smell. Glycerine and the silicate gave no result. These odors were at different times noticed and spoken of by many persons.

Since these experiments were tried, I find a German chemist noticed that silicic acid and cane sugar gave fruity aromas, changing to that of ether. He thought that SiO_2 acted as a ferment. I cannot think so, as I found the result the same in sealed and open vessels, and could trace no absorption of air, evolution of gas, or formation of acids. — *Chas. E. Avery.*

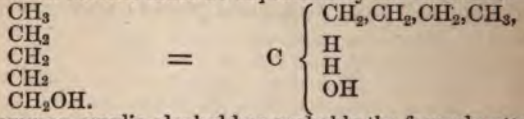
Reduction of Carbonic Acid to Formic Acid. — M. E. Royer has noticed the reduction by the galvanic current of oxalic acid to formic acid. He finds, also, that carbonic acid is similarly converted into formic acid, when a current of this gas is passed through pure water in the porous vessel of a Bunsen's cell. — *Comptes Rendus.*

Synthesis of Hydroxylamine. — By the action of tin and chlorhydric acid upon nitrate of ethyl, Lossen obtained the chlorhydrate of a new base NH_3O, which he termed hydroxalamine. Ludwig and Heine have succeeded in preparing this body by the direct addition of nascent hydrogen to nitric oxide, the reaction being expressed by the equation $2NO + 3H_2 = 2NH_3O$. The nitric oxide was prepared by the action of nitric acid upon ferrous sulphate, and collected in a glass gas-holder, from which it was made to pass through a series of flasks containing tin and boiling chlorhydric acid. After separating the tin and chloride of ammonium, the chlorhydrate of hydroxylamine was obtained, with all the properties described by Lossen. — *Amer. Jour. Science, March,* 1870, *from Ber. deutsch. chem. Ges.*, II., 671 (1869).

Action of Chlorine on Absolute Alcohol. — *Streit and Franz.* — In the preparation of chloral, the authors have noticed, that when chlorine is passed quite rapidly into absolute alcohol, the temperature rises to 62°, and there remains constant. If then the alcohol be exposed to a ray of direct sunlight, there occurs a succession of feeble explosions, the alcohol turns black, and there is deposited a brown powder, which is doubtless carbon; at the same time, the temperature of the liquid rises to 78°. The electric and magnesium lights, as well as that produced by the burning of bisulphide of carbon on melted chlorate of potassium, produce the same effects. — *Jour. für prakt. Chemie.*

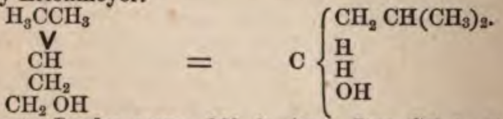
Kryptophanic Acid. — This substance is a normal ingredient of human urine. One method of obtaining it is to treat the urine with an excess of milk of lime. The mixture is concentrated and filtered; the filtrate is acidulated and evaporated to a syrupy consistency, again filtered, and then treated with strong alcohol, which separates the calcium-salt of the kryptophanic acid as a dark, flaky mass. This impure calcium-salt is dissolved in water and mixed with a neutral solution of acetate of lead; a dark-colored precipitate is formed and filtered off; the filtrate containing kryptophanate of lead is treated with strong alcohol, which throws down the kryptophanate of lead in white flakes, from which the acid is set free by means of sulphuretted hydrogen. Kryptophanic acid forms an amorphous, gummy mass, transparent and nearly colorless. It forms salts with the alkalies, with the alkaline earths, and with many metals. In the aqueous solution of its earthy salts, a precipitate is produced by mercuric nitrate. The determination of the composition of the free acid, as well as of its salts, leads to the formula $C_5H_9NO_5$, and the acid would be regarded as dibasic; in some cases, however, it would be regarded as tetrabasic, and the formula would then be written $C_{10}H_{18}N_2O_{10}$. — *Dr. Thudicum before the Chemical Society, March* 3, 1870.

Normal Amylic Alcohol. — Lieben and Rossi have succeeded in obtaining synthetically the normal amylic alcohol, which bears the same relation to the alcohol already known which normal butylic alcohol bears to that obtained by fermentation. Normal cyanide of butyl yields normal valeric acid, which greatly resembles the acid already known, but which has an odor more closely resembling that of butyric acid. It boils at 184°–185° at 736 m.m. When normal valerate of calcium is mixed with normal formate of calcium, and the mixture is distilled in small portions at a time, valeric aldehyde is obtained by boiling at 102° C. This aldehyde, by the action of nascent hydrogen, yields the normal amylic alcohol. The alcohol much resembles that obtained by fermentation, but has a higher boiling-point, 137° C. under a pressure of 740 m. m. The authors have prepared from it the chloride, bromide, iodide, and acetate of amyl, all of which possess higher boiling-points than the corresponding ordinary amylic ethers. The constitution of the normal alcohol must be expressed by the formula: —



$$\begin{array}{l} \mathrm{CH_3} \\ \mathrm{CH_2} \\ \mathrm{CH_2} \\ \mathrm{CH_2} \\ \mathrm{CH_2OH.} \end{array} \quad = \quad \mathrm{C}\left\{\begin{array}{l} \mathrm{CH_2,CH_2,CH_2,CH_3,} \\ \mathrm{H} \\ \mathrm{H} \\ \mathrm{OH} \end{array}\right.$$

While common amylic alcohol has probably the formula attributed to it by Erlenmeyer.



$$\begin{array}{c} \mathrm{H_3CCH_3} \\ \vee \\ \mathrm{CH} \\ \mathrm{CH_2} \\ \mathrm{CH_2\,OH} \end{array} \quad = \quad \mathrm{C}\left\{\begin{array}{l} \mathrm{CH_2\,CH(CH_3)_2.} \\ \mathrm{H} \\ \mathrm{H} \\ \mathrm{OH} \end{array}\right.$$

— *Comptes Rendus*, LXXI., 369, *in Amer. Jour. Sci.* L., *p.* 416.

Transformation of the Fatty Acids into the Corresponding Alcohols. — *Saytzeff.* — The author announces that he has succeeded in transforming the fatty acids into the corresponding alcohols, by treating a mixture of the acid and the chloride with sodium amalgam. The amalgam, containing 3 per cent. of sodium, is introduced into a flask, and to it there is added a mixture of 1 molecule of the chloride, and 2 molecules of acid. The mixture is kept cooled, and, after 12 hours, water is added, and the liquid subjected to distillation. The distillate is saturated with carbonate of potassium. The product which separates is the ether formed by the acid used, and the corresponding alcohol. This ether is then saponified by potash. The author has prepared in this way propylic and butylic alcohol. — *Bull. Soc. Chim., July,* 1870.

Phosphorescence. — *C. E. Avery.* — If a bit of luminous phosphorus — a match-tip for instance — be blown upon, its light ceases until a second or so after the current has stopped; it makes no difference whether the current of air comes from the mouth or from the bellows. The explanation seems to be that the light comes not from the solid phosphorus, but from a vapor clinging to it, yet easily blown away.

Reduction of Isatine to Indigo-Blue. — Bayer and Emmerling state that when pulverized isatine is mixed with 50 times its weight of a mixture of equal parts of terchloride of phosphorus and chloride of acetyl, to which some phosphorus has been added, and the mixture is heated for several hours in a sealed tube at from 75° to 80° C., there separates from fluid, when largely diluted with water, a dark blue substance. This substance, when washed and treated with alcohol, yields a body, in all its properties, identical with indigo-blue, the amount varying from 10 to 20 per cent. of the isatine employed. — *Ber. deutsch. chem. Ges.*

Synthesis of Indigo-Blue. — Emmerling and Engler state that when syrupy nitro-acetophenone is heated in small portions until it forms a hard mass, then dissolved in chloroform, and treated with a mixture of 10 parts zinc-dust and one part soda-lime, there remains, after evaporation of the chloroform, a substance, which, heated quickly in an ignition tube, gives a sublimate containing a small quantity of indigo-blue. The amount obtained is very small compared with the materials employed, and the process is interesting only from a chemical point of view. — *Zeitsch. für Chemie.*

GEOLOGY.

DEEP-SEA DREDGINGS.

In his report of the deep-sea dredgings in the Gulf Stream, Professor Agassiz says: "There is one subject of scientific research, the connection of which with deep-sea soundings cannot fail to lead to unexpected results. When attempting to explain the structure of the stratified rocks, and many other phenomena connected with the general appearance of the earth's surface, geologists have not hesitated to ascribe, in a general way, the fact under observation to the agency of water; but they have rarely entered into such specific detail as would establish a causal connection between all these facts and the cause appealed to. In proportion as the sea-bottom becomes more extensively known, and the character of the materials lying beneath the water, and their mode of arrangement are ascertained with great precision, more accurate comparisons, in consequence of which current views may have to undergo considerable modifications, will certainly be made between geological formations of past ages, including all their deposits of various kinds, and the materials at present scattered in special ways over the ocean floor.

"From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe from the oldest to the youngest formation, there are probably none which have been formed in very deep waters. If this be so, we shall have to admit that areas now respectively occupied by our continents, as circumscribed by the 200-fathom curve or thereabout and the oceans of greater depth, have from the beginning retained their relative outline and position; the continents having at all times been areas of gradual upheaval, with comparatively slight oscillations of rise and subsidence, and the oceans at all times areas of gradual depression, with equally slight oscillations. Now that the geological constitution of our continent is satisfactorily known over the greatest part of its extent, it seems to me to afford the strongest evidence that this has been the case; while there is no support whatever for the assumption that any part of it has sunk again to any very great depth after its rise above the surface of the ocean. The fact that upon the American Continent east of the Rocky Mountains, the geological formations crop out in their regular succession from the oldest azoic and primordial deposits to the cretaceous formation, without the slightest indication of a great subsequent subsidence, seems to me the most complete and direct demonstration of my proposition. Of the western part of the continent I am not prepared to speak with the same confidence. Moreover, the position of the cretaceous and tertiary along the low grounds east of the Alleghany range is another indication of the permanence of the ocean trough, on the margin of which these more recent beds have been formed. I am well aware that, within a comparatively recent period, portions of Canada and the United States which now stand 600 or 700 feet above the level of the sea have been under water; but this has not changed the configuration of the continent, if we admit that the latter is in reality circumscribed by the 200-fathom curve.

"Geologists have appealed very freely to oceanic currents as accounting for the presence of loose materials upon the surface of the earth. But now that the actual mode of distribution of such loose materials under the action of extensive and powerful currents begins to be known, those who explain the facts in this way are bound to show that their arrangement actually agrees with the effects of oceanic currents. I must confess that I have looked in vain in the trough of the Gulf Stream for traces of the characteristic mud which pours from the mouth of the Amazon in quantities sufficient to discolor the water of the ocean for a great distance from shore; and yet the equatorial current of the Atlantic is one of the greatest and most powerful of all known currents.

"Another side of this subject is also immediately connected with deep-sea soundings. Geologists, and especially those of the school of Lyell, have again and again assumed the slow rising of extensive tracts of land from beneath the water, and taken all sorts of loose materials irregularly scattered over the surface of the land as evidence of its former submersion. But since the dredge has been applied to the exploration of the deep, and a great variety of animals, in a profusion rivalling that of shoal water, have been brought up, not only from the immediate vicinity of the land, but at various distances in increasing depth from one to two, and even many hundred fathoms, no observer is justified in considering extensive deposits of loose materials as marine in which no traces of marine organic remains are found. The very mud and sand of the deep teem with innumerable microscopic living beings, the solid parts of which are easily detected in the smallest samples of marine deposits, and may therefore afford a satisfactory test where larger animals or plants are wanting. Now, after surveying the whole width of our western prairies without finding anywhere a sign of marine animals or plants, I cannot see that there is any evidence of their marine origin, or of the influence of oceanic currents in accumulating or distributing the loose materials scattered over those vast plains. On the other hand, I have ascertained that the foundation rock upon which these materials rest is everywhere polished, grooved, and scratched in the same characteristic manner as the well-known glaciated surfaces, wherever exposed. I have seen such polished rocks in the valley of the River Platte, not far from Omaha, and am now satisfied that the whole extent of the country between the Alleghanies was one unbroken glacier bottom. The scratched pebbles found among the loose materials of the great prairies confirm this view. For similar reasons, I am satisfied that the valley of the Amazons has not been under the level of the ocean since the tertiary period."—*Report upon Deep-Sea Dredgings in the Gulf Stream during the Third Cruise of the U. S. Steamer Bibb, addressed to Prof. Benjamin Pierce, Superintendent U. S. Coast Survey; in Bulletin of the Museum of Comparative Zoölogy*, 1869, *No.* 13, *p.* 363.

In the last deep-sea exploring expedition of H.M.S. *Porcupine*, in the Bay of Biscay and along the Atlantic coasts of Spain and Portugal, Mr. Gwyn Jeffreys procured, from a very considerable depth (in the neighborhood of 1,000 fathoms), many species of mollusca, some of which had hitherto been supposed to exist in the fossil state only, having been found in the latter tertiary formations of Sicily and Calabria. A number of the species are those which inhabit Arctic seas, and Mr. Jeffreys submits for consideration the following questions: 1. "Have not all the deep-sea species of European mollusca originated in the north, and spread southwards in consequence of the great Arctic current?" 2. "Inasmuch as the Pliocene division of the tertiary formation is now ascertained to contain scarcely any extinct species, and as future explorations may reduce the percentage of such species to *nil*, may not that artificial division hereafter merge in the quaternary formation, and the tertiaries be restricted to eocene, miocene, and pliocene?"

Chemical Examination of Mud from the Bed of the Atlantic.—James Mahoney.—The author had examined chemically a specimen of mud from the deepest dredging made by the *Porcupine*, 2,435 fathoms. The composition was found to be as follows:—

Silica,	26.60
Peroxide of iron and phosphates,	3.80
Protoxide of iron,	0.08
Carbonate of calcium,	58.80
Carbonate of magnesium,	1.76
Sulphate of calcium,	trace.
Soluble salts,	4.20
Organic matter,	2.30
Water,	2.50
	100.04

The silica was found, under the microscope, to consist chiefly of minute structureless fragments, some of them being crystalline. A small number of diatoms were also found. The carbonate of calcium consisted of larger organisms (class *Foraminifera*), some still containing the small particle of jelly-like matter constituting the animal substance of these organisms, and called *sarcode* by Dujardin. These doubtless yielded the organic matter noted in the analysis. The soluble salts were accounted for by the evaporation of the sea-water with which the mud was charged when taken up.—*Before the Glasgow Philosophical Society, reported in Chemical News.*

Formation of Limestone.—The littoral and deep-sea dredgings, undertaken by the United States Coast Survey in the Gulf Stream in the vicinity of Florida, have contributed much information, not only with regard to the fauna of the ocean at various depths, but also with regard to the geological history of the past. In speaking of the formation of limestone, now going on near the Florida coast, Professor Agassiz (in his report quoted above) says: "We find upon the Florida reefs, as well as between the innumerable keys stretching along the American coast, and upon the coral plateau sloping towards the main trough of the Gulf Stream, extensive beds of regularly stratified rocks of various kinds." One area in particular, beginning at a depth of about 50 fathoms and extending to a depth of about 250 fathoms, constitutes a broad slanting table-land. The floor is rocky; "it is, in fact, a limestone conglomerate, a kind of lumachella, composed entirely of the solid remains of organized beings, a true concretionary limestone, such as we might find in several levels of the jurassic formation and more especially in that horizon which geologists call *Coral Rag*. Large fragments of this rock were brought up by the dredge; so that its structure and characteristic remains of animals could be studied at leisure. I do not know that there is on record in the annals of our science a more direct illustration of the manner in which mountain-masses of calcareous deposits have been accumulated on the bottom of the ocean. Such a formation exists nowhere else within the range of the Gulf Stream, unless it should be hereafter ascertained that a similar deposit extends along the submarine border of our continent, edging the American wall of the deeper part of the Atlantic trough. But in the shoal waters intervening between the coast of the peninsula of Florida and the keys and reefs, there exist various deposits of an entirely different structure, the accumulation and increase of which are constantly going on. The most extensive of these formations is a regularly stratified oölitic rock, the grains of which vary from imperceptible granules to larger and larger oölites, approaching the dimensions of pisolites, and cemented together by an amorphous mass of limestone mud. The oölites themselves are formed in the manner first described by Leopold von Buch. Hard particles of the most heterogeneous materials, reduced to the smallest dimensions and tossed to and fro in water charged with lime, are gradually coated with a thin film of limestone, and then another and another, until they sink to the bottom to be further rolled up and down the sloping shore bottom until they become cemented with other similar grains, and form part of the growing limestone bed. Of course, the finer oölites are seen nearest the shore line, and it is instructive to see at low tide the little ripples of successive larger oölites left dry as the water subsides. Naturally these materials are frequently thrown up along the beaches in layers of varying thickness, and in course of time become cemented, and are transformed into solid rock, over which crusts of hard, compact limestone are in the end formed by the evaporation of calcareous water dashed upon the dry surfaces.

"In very shallow waters which are not powerfully affected by tidal movements, and upon the bottom of which no oölites are forming, we find extensive beds of a dull amorphous limestone, formed of lime mud, alternating with seams of a more compact hard limestone in which a few oölites may occasionally be seen that were floated over the flats in which such formations are going on. These deposits resemble the marly limestone of the Oxford beds. Of course these different rocks may alternate with one another as, owing to the increase of the whole formation, the conditions for the deposition of one kind of rock may be followed by those favoring another combination. Again, in consequence of the changes in the directions of the currents, or as the result of a heavy gale, considerable deposits, which have been going on regularly for a long time, may suddenly be worn away and destroyed, giving rise in turn to the formation of conglomerates made up of limestone fragments of various structure united together into very peculiar conglomeratic pudding-stone with angular materials. The compact limestones are frequently as hard as the hardest limestones of the secondary formation, have a conchoidal fracture, like the most compact Muschelkalk of the triassic period, and may ring under the hammer.

"The extensive area occupied by the keys and reefs of Florida, including the sloping coral plateau of the American side of the Gulf Stream bottom, may fairly be compared to the jurassic formation as it stretches across Central Europe and further east in the direction of the Caucasian and Himalaya Mountains. Indeed, the jurassic formation, as a whole, bears the same relation to the older deposits upon which it rests, as the modern American coral formation sustains to the older parts of the coast of our continent. During the geological middle ages the jurassic formation was the submarine margin of a growing continent, as the Pourtales plateau forms at present the southern margin of North America."

DISTRIBUTION OF MARINE LIFE.

"The *Lightning* and *Porcupine* dredgings have fully established the position that the distribution of marine life is much more closely related to the *temperature* of the ocean-bottom than to its depth. This is most clearly evidenced by the results of the careful exploration of the channel of from 500 to 650 fathoms' depth, which separates the plateau which supports the northern extremity of Scotland from the Faroë Banks. For we have shown that while the *surface temperature* of the channels is everywhere nearly the same, and indicates the derivation of its upper stratum from a warmer source, a considerable part of the deeper portion of this channel is covered by a *frigid stream*, bringing a temperature as low as 29.5° from the Arctic Ocean; this stream having in some places a depth of 2,000 feet. Thus the bottom temperature, at depths of from 100 to 600 fathoms, is about 45°, while there is a cold area, on which the bottom-temperature at like depths is 30°, or even lower. We have traced these two areas at corresponding depths within about 20 miles of each other; and where the bottom was unequal, — the slope of the plateau at the edge of the cold area, or of a bank in its midst, raising its bottom out of the *cold* stream into the *warm* which overlies it, — a difference of 18.5° was found within *eight miles*. No contrast could well be more striking than that which presented itself between the faunas of these two areas. The Globigerina-mud was rigorously limited to the *warm;* and of the animals living on its surface, a large proportion were characteristic of the warmer temperate seas. The bottom of the cold area consisted of sand and stones, and of the animals which were abundantly distributed over it a large proportion were essentially boreal. In the shallower portions of the cold area, where an intermediate bottom-temperature prevailed, an intermixture of the two faunæ, corresponding with the border position of this area between the temperate and boreal provinces, was readily traceable.

"Here, then, we have the remarkable fact that two deposits may be taking place within a few miles of each other at the same depth and in the same geological horizon (the area of one penetrating, so to speak, the area of the other), of which not only the mineral character but the faunæ are alike different; that difference being due on the one hand to the direction of the current which has furnished their materials, and on the other to the temperature of the water brought by that current. If the *cold* area were to be raised above the surface, so that the deposit at present in progress upon the bottom should become the subject of examination by some geologist of the future, he would find this to consist of a sandstone formed by the disintegration of the older rocks, the faunæ of what would in a great degree bear a boreal character; whilst if a portion of the *warm* area were elevated at the same time, the geologist would be perplexed by the stratigraphical continuity with the preceding of a cretaceous formation, the production of which entirely depends upon the extensive development of the humblest forms of animal life under the influence of a higher temperature, and which includes not only an extraordinary abundance of sponges, but a great variety of other animal remains, several of them belonging to the warmer temperate regions. He would naturally suppose these widely different climatic conditions to have prevailed at different periods, and would probably have had recourse to the hypothesis of a "fault" to account for the phenomenon. And yet these formations have been shown to be going on together, at corresponding depths, over wide contiguous areas of the sea-bottom, in virtue solely of the fact that one area is traversed by an equatorial and the other by a polar current. Further, in the midst of the land formed by the elevation of the cold area, our geologist would find hills, some 1,800 feet high, covered with sandstone continuous with that of the land from which they rise, but rich in remains of animals belonging to a more temperate province, and he might easily fall into a mistake of supposing that two such different faunæ occurring at different levels must indicate two distinct climates separated in time, instead of indicating, as they have been shown to do, two contemporaneous but dissimilar climates, separated only by a few miles horizontally and by 300 fathoms vertically.

"The determination of deep-sea temperature is therefore of the greatest interest to the geologist as affecting his interpretation of the phenomena on which his belief in a former general prevalence of a glacial climate is founded. For if a glacial temperature should be found now to prevail, and types of animal life conformable thereto should be proved to be diffused over the deeper portion of the existing sea-bed in all parts of the globe, it is obvious that the same may have been the case at any geological epoch; for there must have been deep seas in all periods, and the physical forces which maintain the oceanic circulation at the present time must have been always in operation, though modified in their local action by the distribution of land and water existing at any particular date. And as the elevation of the present deep-sea bed of even the intertropical oceanic area would (if we have correctly interpreted the results of our own and of others' observations) offer to the study of the geologist of the future a deposit characterized by the presence of polar types, so must the geologist of the present hesitate in regarding the occurrence of boreal types in any marine deposit as adequate evidence *per se* of the general extension of glacial action into temperate or tropical regions. At any rate it may be considered as having been now placed beyond reasonable doubt that a glacial submarine climate may prevail over any area, without having any relation whatever to the terrestrial climate of that area."—*Extracts from a Letter of Dr. Carpenter to the Editor of Nature.*

Distribution of Coccoliths.—Dr. C. W. Gümbel has recently published an important paper containing an account of investigations on deep-sea mud. The finest portion of this mud is of great interest to the geologist as well as to the zoölogist, consisting mainly of a mass of little granules,—the so-called *Coccoliths* (*Discoliths* and *Cyatholiths*),—and of granulous, flaky lumps,—the so-called *Bathybius*. Dr. Gümbel feels in a position to confirm the conclusions of Huxley, Carpenter, and Haeckel with respect to their organic nature, and, from his investigation, to assert that *Coccoliths* occur in all seas and at all depths.

Dr. Gümbel further maintains that the distribution of *Coccoliths* in time is not less remarkable than the present distribution in space. There is proof, he says, that they are to be found in "almost all sedimentary formations." Referring to their distributions in various formations, he says: "But, besides the *Coccoliths*, another ingredient demands attention. In the case of the chalk of Mendon, rich in *Coccoliths*, if the carbonate of calcium be removed by means of diluted acids, there remains a flaky and cuticular residue, in which are found thin transparent flakes, full of the smallest granules, and resembling *Bathybius* in a high degree. . . . This places their organic nature beyond question, and firmly establishes their relationship with the *Bathybius*. The imperishableness of this substance is, indeed, very remarkable."

After stating that the *Coccoliths* occur in all the soft marls and limestones of the jurassic and liassic formations, "The Muschelkalk," continues Dr. Gümbel, "appeared for a long time to be proof against every experiment. Every specimen of marl which I examined was apparently free from *Coccoliths*. At last I had the good fortune to discover traces of them in a somewhat impure piece of rock-salt from Wilhemsglück. Even here they show themselves extremely sparingly, but in the company of flakes, which are not unlike *Bathybius*. To the present time I have in vain examined the similar rock-salts of Berchtesgaden and Stassfurt; and, as yet, indications of *Coccoliths* in the Permian formation and the coal-measures are wanting. On the other hand, the soft marls of the mountain limestone of Regnitzlosan, the soft marls of the Conodont strata of the Baltic provinces, the Trenton marl of New York, and even the siliceous limestone of the Potsdam sandstone, contain some traces, although to an extremely small extent.

"These facts all point to the conclusion that in the majority of calcareous marine deposits the *Coccoliths* originallyformed a more or less essential part of the calcareous masses, and that, in thick or granulous, and particularly ancient limestone rocks, they can no longer be perceived, either on account of the opaque character of the rocks, or because they have been made by some change wholly or in part unrecognizable, or have been altogether destroyed. I have been able by some experiments to throw further light upon this subject. That these smallest organic bodies can be recognized in hard limestones only in the rarest cases, even when it contains them in great numbers, I convinced myself, by means of thin slices, which I made from deep-sea mud, thoroughly dried and rendered hard by repeated soaking in diluted Canada balsam and heating, and also from writing-chalk, made hard in the same way, and rich in *Coccoliths*. The infinite numbers of finest granules and rings are so massed together, one over the other, that it must be regarded as an extremely rare case when a *Coccolith* is clearly seen here and there at the very thinnest edges." —*Nature, Nov.* 3, 1870.

THICKNESS OF GLACIERS.

In his memoir "On the Mechanical Properties of Ice," published in the "Philosophical Magazine" for January, 1870, Canon Moseley arrives at a conclusion in regard to the crushing of ice, to which I am unable, without some qualifications, to agree. In his experiments ice was crushed under a pressure of 308.4 pounds on the square inch, and he concludes that if a glacier is over 710 feet in thickness, the ice at the under surface must be crushed by the incumbent weight. Professor Philips also made some experiments on the crushing of ice, and he came to the conclusion that the height of a crushing column of ice is between 1,000 and 1,500 feet, and concluded also if a glacier were to exceed this in thickness the ice would lose its solidity. (*See a paper on Glacial*

Striation, read before the Geological Section of the British Association, 1865.)

Whether the height of a crushing column of ice be 710 or 1,000 or 1,500 feet is of no consequence whatever as regards the possible thickness of a glacier. No doubt a piece of ice solidified under no pressure would be crushed to powder were it placed under a glacier 1,000 feet in thickness or so; but after being crushed, it would resolidify, and would then probably be able to sustain a pressure of 2,000 feet of ice. This follows as a necessary consequence from the property of regelation. There is as yet, so far as I am aware, no known limit to the amount of pressure which ice can sustain. There probably is a limit; but what that limit is has not yet been determined. Canon Mosely says that "There is no glacier alleged to have so great a depth as 710 feet." The Humboldt glacier in North Greenland, according to Dr. Kane, has a depth of more than three times 710 feet. Dr. Hayes found in Baffin's Bay icebergs (which are just pieces broken off the ends of glaciers) aground in about half a mile of water, while on the Antarctic continent we have reasons for believing that the ice is in some places over a mile in thickness.—*J. Croll.—Amer. Jour. Science, from Geological Magazine for June*, 1870, *p*. 276.

THE DESCENT OF GLACIERS.

De Saussure, who was the first to study with care the descent of glaciers, held that glaciers slip down the slopes on which they rest as any other body would slip down an inclined plane. As soon, however, as it appeared that the glacier did not move forward as a body, but that different portions of the mass moved with different velocities, there was propounded the *viscous* theory, which supposed the ice to be a fluid, and not the solid thing it seems to be. This theory was ably advocated by the late Principal James Forbes. The experiments of Faraday and Tyndall led to the *regelation* theory, which supposes that by the pressure exerted from behind the ice is crushed through and over the irregularities of its course, and is united again by pressure to a homogeneous mass.

In regard to this subject of the descent of glaciers, Canon Moseley says: "At this stage the question had assumed this new form. If ice be a viscous fluid, according to the viscous theory, is it fluid *enough* to descend by its own weight; or, if it be solid, according to the *regelation* theory, is it *little* enough solid so to descend?

"If, instead of ice, a glacier were of water, it *would* obviously descend by its weight. The same would be true if it were of oil, or soft mud, or quicksilver, or probably of pitch; but if it were of iron, or of copper, or of lead, it would not descend by its weight only, unless, indeed, these metals were in a state of fusion. A quicksilver glacier would descend by its weight only, because it shears easily; a cast-iron one would not, because it shears with difficulty. There must, therefore, exist a relation between the shearing force and the weight of a given volume of a glacier, so that it may just descend by its weight only. Now it is possible to investigate mathematically what that relation is. I have made that investigation. (*See Phil. Mag., May,* 1869.)

"The resistances opposed to the displacement of a glacier are, (1) Those which oppose themselves to the shearing of one surface of ice over another, which is continually taking place throughout the whole mass, by reason of differential motion; (2) The friction of the superimposed laminæ of ice upon one another, which is greater in the lower than the upper; (3) Abrasion of ice on the bottom and sides of the channel of the glacier. If it descends by the weight only, then the work of its weight in its descent through any distance must at least equal the sum of the works of all these resistances. It is of course impossible to represent this relation mathematically in respect to an actual glacier having a variable direction and an irregular channel and slope; but in respect to an imaginary one having a constant direction and a uniform channel and slope, it is possible. I have made that calculation, and it results from it that the unit of shear in ice (that is, the force necessary to make one square inch of ice shear over another square inch) must not be more than 1½ pound, that a glacier may descend by its weight only. If the unit of shear in ice be more than that, the glacier cannot descend by its mere weight on a slope like that of the Mer de Glace. But it is a great deal more than that. It requires from 60 pounds to 120 pounds to shear one square inch of ice over another square inch. The ice of the Mer de Glace cannot therefore descend by its weight only; it does not shear easily enough. It must be ice of about the consistency of soft putty to descend by its weight only, for that substance shears with a pressure of from 1½ pound to 3 pounds per square inch.

"Ice, therefore, if it be fluid, is not fluid *enough*, and if it be solid, it is *too* solid to descend by its weight only. There must be some other force to help it down besides its weight, certainly 45 times greater, and, possibly, 90 times. This result is directly opposed to the viscous theory and to that known as the theory of regelation, both of which attribute the descent of glaciers to their weight as the only cause. It reveals the existence of some other force."

This force Canon Moseley finds in the heat from the sun, and the effect is produced by the dilatation of the ice within the mass, where it cannot be converted into the liquid state. He found that a sheet of lead, placed on an inclined plane and exposed to the rays of the sun, gradually worked its way down, on account of the contraction and dilatation of the mass with changes of temperature.

"How much heat entering the surface of a glacier is necessary to this result has been made the subject of calculation. Supposing the depth of the ice to be the same as that at Tacul, its motion at different depths, that which Tyndall found it to be there, and its surface motion, that which he measured lower on the Mer de Glace, at Les Ponts, and supposing the resistance to shearing of ice to be 75 pounds per square inch; then the mechanical work, which acting within the mass is necessary to put the glacier in motion, as it actually moves, is 61¾ units of work per square inch of the surface of the glacier per day." (*See Proceedings of the Royal Society, January*, 1869, *p*. 207.)

"Now this quantity of work would be supplied by .0635 heat-unit entering the ice per square inch of the surface per day, and diffusing itself through it, each heat-unit being the heat necessary to raise 1 pound water by 1° F. Far more than this heat probably passes the surface, and enters into the ice of a glacier on days such as that when the motion was observed, which serves as the basis of these calculations."

This theory presupposes that the ice in the interior of the glacier is a *solid*. In reply to the objection which might be brought forward, that according to the experiments of Agassiz the temperature of the interior of the glacier is nearly constant at 32° F., Canon Moseley says: —

"Nothing can be concluded from these experiments, because the thermometers were not *frozen into the ice* of the glacier, or the mouths of the borings so effectually stopped as to prevent the access of air or the percolation of water from the disintegrated ice of the surface. The included thermometer could but remain at zero (Centigrade), however low might be the temperature of the surrounding ice, for the water of the air continually freezing on the sides of the boring would raise the temperature around the bulb by the latent heat set free in freezing to 0° C. A thermometer is, in short, incapable of taking the temperature of ice, unless the ice be dry. — *Proc. Royal Institution*, 1870.

DISCOVERY OF THE DIAMOND IN BOHEMIA.

In a letter to H. Sainte-Claire Deville, M. Schafaritz, of Prague, announces the discovery of the diamond at Dlaschkowitz, about 60 kilometers north-west of Prague, in a bed of gravel situated in the Cretaceous formation. The gravel, which consists, in part, of débris of the basalt of the Mittelgebirge, together with gneiss and serpentine, contains a large proportion of quartzose sand, rich in grains and worn crystals of various precious stones, among which the most important are pyropes (Bohemian garnets containing oxide of chromium) and zircons. There also occur red and black spinel, chrysolite, kyanite, pyroxene, amphibole, etc. The single specimen of diamond found is of irregular, cubical form, from 2.5 to 4 m. m. in diameter, and weighs 57 mgrm.

M. Schafaritz says: "This discovery of the diamond at Dlaschkowitz appears to me important, not only because it is the first authentic case of its occurring in Europe (excepting in the Ural mountains), but also in a geological point of view. Up to the present time the diamond has been found only in formations which everywhere are almost identical and characterized both by their geological horizon between the early sedimentary and the azoic rocks, and for the association of the diamond with gold and *platinum*. Here the conditions are entirely different; no gold or platinum has been found, and the rocks on the one side are eruptive, and on the other of recent sedimentary origin. Almost all the minerals which accompany the pyrope of Dlaschkowitz, Podsedlitz, and Triblitz, are found in different parts of Bohemia in their gangue of basalt, but I see no reason *à priori* why the basalt should not contain diamond. The hypothesis of the organic origin of the diamond, resting on the authority of Brewster and other observers, has always appeared to me to offer fewer difficulties than any other; but hypothesis is nothing in the presence of a fact; besides, it has not been proved that the diamond would be consumed by the fusion of the basalt." — *Comptes Rendus*, LXX., *p*. 140.

According to Rose, the features of the Bohemian locality are not so different from those of the diamond-producing districts of Brazil, for the serpentine of Bohemia may be derived from an amphibolite or similar rock, which is found in Brazil with itacolumite, and which, as well as the itacolumite, contains diamonds. — *Comptes Rendus*, LXX., *p*. 398.

NEOCOMIAN STRATA OF NORTH EUROPE.

Mr. Judd, of the Geological Survey of England and Wales, thus concludes a paper "On the Neocomian Strata of Yorkshire and Lincolnshire, with Notes on their Relations to the Beds of the same Age throughout Northern Europe:"—

"We have thus seen that the Neocomian beds of Yorkshire and Lincolnshire are the most westerly development of a great mass of strata, of the same age, stretching over a wide area in Northern Europe. It is true that the beds of this age are neither so well exposed, nor do they attain so great a thickness, as in the south of Europe; but they nevertheless present us with a remarkably similar succession of faunæ. At the eastern and western extremities of the areas in Brunswick and in Yorkshire respectively, the marine series is complete, and we have the three divisions of the Neocomian formation all developed; but in the intermediate districts of Westphalia, Hanover, and the Hartz, the marine beds represent only the Upper and Middle Neocomian, and these rest upon the fresh-water strata of the North-German Wealden. The section at Speeton Cliff derives additional interest from the fact that it is by far the most complete exposure of the Neocomian beds over the whole of the great North-European area. The sections elsewhere are more or less isolated and fragmentary; but at Speeton we find the key by means of which they may be identified and correlated. We have seen that, over the North-European area, a remarkable uniformity of character is maintained among the Neocomian strata (and the same is, to a certain extent, true also of the Cretaceous and Jurassic), indicating that this district forms a natural province, not improbably representing an ancient sea-basin. The ridge of Palæozoic land traced by Mr. Godwin-Austen, in his celebrated memoir 'On the Possible Extension of the Coal-Measures beneath the South-Eastern Part of England' (*See Quar. Jour. Geol. Soc.*, XII., 1856, *p*. 38), may not improbably have formed the barrier between this Anglo-Germanic and the Anglo-Parisian basin." — *Quart. Jour. Geol. Soc.*, XXVI., *p.* 346.

TERTIARY DEPOSITS OF AUSTRALIA.

The following extracts are taken from the concluding portion of a paper "On the Fossil Corals (Madreporaria) of the Australian Tertiary Deposits," read before the Geological Society, of London, by P. Martin Duncan, F.R.S., Sec. of Geological Society: —

"When the list of the fossil corals of the Australian tertiaries is compared with that of the forms living in the Australian and New Zealand seas, it becomes evident that none of the recent species are represented in the Cainozoic strata. Of the 20 genera now existing around Australia, out of the immediate vicinity of coral reefs, only 3 had species in the tertiaries. The alliance of the coral faunæ of the Australian tertiaries and of the surrounding coral seas is thus very slight; and the recent species have not been found in the uppermost of the tertiaries. There are 3 species common to the Australian and the European Cainozoic deposits; so that the alliance of the Australian fossil fauna is as great with the European Cainozoic fauna as it is with that of the corals of the tropical seas to the north-east.

"The corals of the Australian tertiaries are very characteristic. They were not reef-builders, but forms which tenanted the sea-bottom, from low spring-tide mark to the depth where Polyzoa abound. The species of the different beds have so great a general and exact resemblance, that they do not offer evidence of any great biological changes having occurred during the deposition of the whole of the fossiliferous tertiary sediments. It is therefore not consonant with the rules of classificatory geology to subdivide the sediments into such series as Oligocene, Lower, Middle, and Upper Miocene, and Pliocene, which for the most part have very distinct faunæ in the European area. The diagnosis of the age of the tertiary deposits by the percentage system cannot as yet be applied to the Australian sedimentary beds, in consequence of the mollusca not having been sufficiently studied; and the comparison between the existing Australian coral fauna and that of the tertiaries would give a much older geological age to them than is warranted by the physical geology of the area. During the deposition of the tertiaries there was much disturbance in the currents and constant alterations in the depth of the coralliferous sea, whose bottom and shores were formed by the silurians, old basalts, and carbonaceous sandstones of Victoria. The conglomerates and pebbly sandstones were of course formed during different marine conditions from those which existed during the deposition of the clays and clayey sands. As the depth increased during the subsidences which evidently followed every basaltic outpouring, the calcareous element mingled with the wash-down from the land, and finally it increased to such an extent that it encroached upon the area formerly occupied by littoral deposits, and even in some places covered the rocks whose denudation had produced the conglomerates. There were temporary upheavals during this general subsidence; and the leaf-beds, with associated clays, bear testimony to them. The relations of leaf-beds, clays, gypsum, and basic sulphate of iron, so frequently observed in Europe, are repeated in the Australian deposits.

"It is reasonable to admit, especially when the long duration of the time which was occupied by the formation of the series over the fossiliferous deposits is considered, that whilst the vast central area of Australia was a sea, there was open water to the north, with reefs in the Java district, and corresponding formations opened into what is now the Mediterranean and the Sahara to the north-west. The Indian peninsula, and the area now occupied by the Himalayas and stretching far away to the east, were not part of a great continent; and these marine tracts equalled the terrestrial in magnitude. The greater part of the American continent was submerged, and the Caribbean Sea was a coral area. Where was the bulk of the land when the coral sea stretched round the tropics? It could only have been to the extreme north and south. New Zealand and South Australia were therefore bounded to the north by a coral sea, and to the south by the deep ocean, as now. So far as the coral fauna is considered, this separation of the Australian sea from the European area by a coral tract inhabited by a distinct fauna, which could only exist under conditions very diverse from those witnessed in Victoria, is explanatory of the comparative isolation of the remote assemblages of species, supposing them to have existed during the same geological period. The enormous range of deep-sea corals is now admitted; and it is certainly very remarkable that so few of them should have become common to the European and Australian tertiary deposits. The absence of any littoral connection between Australia and the tracts to the north of it during the whole of the tertiary period, and the remoteness of the south of its area from any great centres of frequent terrestrial oscillations, may explain the persistence of type which is so characteristic of a large portion of its fauna and flora. This persistence was infinitely less in Europe, on account of the more frequent changes in the physical geology of its area, each change inducing emigration of some forms, unusual competition with others, and occasional free scope for rapid multiplication. Hence the distant and comparatively quiet area of Australia was tenanted by the same species, whilst vast biological and geological alterations took place in the area which was formerly considered the type by which all others could be compared. The permanent upheaval of the central and northern area of Australia, the extinction of its volcanoes, and the change in its coral fauna, were grand phenomena.

"The denudation which occurred during the upheaval of the Australian area was enormous, and it is to be estimated by the extent of the unfossiliferous deposits which cover the fossiliferous marine tertiaries. There are no proofs of any glacial phenomena in Australia; and subaerial denudation probably went on during the whole of that vast period, and has continued.

"I would suggest that the word tertiary should be only used relatively in Australian geology, and that the strata (so ably mapped by the surveyors) which are above the carbonaceous sandstones should be called Cainozoic. The term Lower Cainozoic would refer to all the deposits beneath the Mount-Gambier series, the Middle to the deposit, and the Upper to all above.

"At present all that can be arrived at concerning the relative position of the Australian fossiliferous tertiaries and their physical geology may be quickly summed up. They formed on a sea-bottom of the oldest rocks, in increasingly deep water, during a period when the denudation of the neighboring coast line to the east and north-east was rapid. They were very distant from the reef-area of the period; and the physical conditions of such an area were never present during the deposition of the madreporaria, polyzoa, echinodermata and mollusca, which have a facies characteristic of all the European marine tertiary deposits above the Nummulitic. They were subjected to frequent volcanic outbursts, which covered large areas with basalt and ash, and they were covered, after the general upheaval of the centre of Australia, with lacustrine, dune, river, and torrent deposits, whose depth testifies to the enormous denudation of the older rocks. The condition of the high land on the extreme east and west of Australia was probably that of dry land during the whole Cainozoic period, and these districts bounded the tertiary sea."—*Quar. Jour. Geol. Soc.*, XXVI. (1870), 313.

ABYSSINIAN GEOLOGY.

From the report of Mr. W. T. Blanford, late geologist to the Abyssinian expedition (1867–68), we learn that the formations met with throughout the region traversed were: 1. Recent, consisting of soils of the highlands, including *regur*, or cotton soil, similar to that found in India, and alluvial deposits on the coast. 2. The volcanic series which skirt both coasts in the southern portion of the Red Sea. This group, which is but poorly developed on the west coast of Annesley Bay, Mr. Blanford proposes to call the Aden Volcanic Lines. 3. Trappean series. This grand collection of beds, which forms the Abyssinian highlands, including Magdala and the Ashangi groups, consists of two divisions, which are unconformable to each other, the former (the Magdala group) consisting of trachytes and dolerites, and the latter (the Ashangi group), entirely composed of dolerites of great thickness and bedded volcanic rocks, lavas, and ashes. Through this *trappean* series near Bethor, not far from Magdala itself, the Jitta river has cut its way, and now runs at a depth of 3,500 feet, in a valley probably more than a mile in width. The sides are extremely steep, often perpendicular. The beds on both sides appear exactly to correspond. A well-marked river-terrace half way down, indicated on both sides of the stream, records the fluviatile origin of the gorge. "Of all the grand scenery," says Mr. Blanford, "met with in Abyssinia, none equalled this wonderful gorge." His descriptions remind one of the Grand Cañons of the Colorado River. 4. The *Anotolo limestone* is of oölitic age and contains *Ceromya similis*, *Trigonia costata*, and other characteristic fossils, reminding one strongly of British forms. 5. *Adegrat sandstone*, a massive formation, occupying a very extensive area in northern Tigre, and perhaps representing the coal-bearing rocks known to exist north-west of Lake Dembea, but yielding no fossils. 6. Metamorphic rocks of various mineral character, with a general north and south strike due to pre-existing cleavage. — *Quarterly Journal of Science, July*, 1870.

DIAMOND FIELDS OF SOUTH AFRICA.

In relation to the geology of the diamond fields of South Africa, which are coming so extensively into notice, Dr. John Shaw says: —

"In July of this year I made considerable observations in the Vaal Valley, which show that the rocks are chiefly trappean, metamorphic, and conglomerate in character. I detected no pure granite formations, but syenite is, however, developed extensively, and seems to be the base of the whole system of rocks at Klipdrift. A very singular rock appears in the shape of isolated boulders on the summits of the Kopjes, and especially of the celebrated Ald Kopje. This I take to be graphic granite (binary granite), or what Dana would call 'granilite,' consisting solely of quartz and large crystals of felspar.

"Above the syenite is a trap-conglomerate in some places, in others are amygdaloids, and protruding through these again basalt, assuming everywhere the hexagonal structure, and arising in some places into insulated and compacted columns.

"In some of the Kopjes there are remains of stratified rocks, — clay schists, sandstone, chalk (or something very like it), which are evidently the last vestiges of a vast series of sedimentary strata, which formerly covered the whole present contour, but which have gradually given way to denudation and cataclysm.

"Such is the character of the present rock system at Klipdrift, and, with a few additions (mainly superincumbent), of the whole rock series of the Vaal region.

"On the summits of the Kopjes, and, as a matter of course, in the crevices between the basaltic boulders, is an alluvial gravel. In this are found diamonds, and on the surface some have been found, indicators of the wealth beneath. The pebbles of sandstone, quartzite, crystalline sandstone, granite, clay-slate, agate, tourmaline, iron pyrites, garnet, garnet spinel, etc., which compose this alluvium, are all roundedly polished and water-worn, and are imbedded at Klipdrift in a brownish fatty earth.

"The question arises, Is this alluvium of recent or ancient formation? Did the majority of the pebbles exist in the form of a conglomerate, aggregated from the alluvium of a former age? Or have the Kopjes at no very late period been the bed of the river?

"It is my opinion that the water-worn gravel has been under the influence of running water prior to the last great changes which formed the present landscape. The greater number of the water-worn pebbles and boulders are of the basalt of the Kopjes. Many of them are crystalline sandstone, others are water-worn fragments of clay-slate, sandstone, etc., of the sedimentary rocks which exist in the Kopjes. The agates, tourmalines, and garnets are undoubtedly from some superincumbent conglomerate sandstone which has yielded to denudation and no longer exists at Klipdrift, and also to a considerable extent from the amygdaloidal trap everywhere prevalent. I have in my possession from the Vaal a single fragment of red sandstone containing garnets, but I have not succeeded in tracing this to its source.

"It will, therefore, be sufficiently apparent that there must have existed, at a remote geological period, a series of metamorphic and sedimentary rocks which lay above the present rock system of the region, and that, through successive disturbances and persistent denudation, these have been worn away, forming in great part the alluvial soil of the present surface. In some few spots remnants of this series still exist, as in the clay-slaty crystalline sandstone of some of the Kopjes now worked for diamonds, and generally in the fragments of sedimentary rocks scattered over the surface along the whole Vaal Valley.

"I am decidedly inclined to think that the diamonds have not been washed down from some higher region. I hope to show, in another article, that the Free State possesses an independent diamondiferous centre, and that there no river has existed at any time, for there is no evidence of water-wearing, and the soil is not alluvial. Diamonds have been discovered 2 hours' distance from Potchefstroom, and all down the Vaal to its junction with the Orange River, and thence to 10 hours' distance below Hope Town. This is a stretch of at least 500 miles. I believe the diamonds have come from some rock which may now have vanished, but which existed formerly throughout the whole region." — *Nature, Nov.* 3, 1870.

LAURENTIAN GRAPHITE OF CANADA.

In the Journal of the Geological Society, for 1869, Dr. Dawson publishes a paper, in which he sustains the view that the graphite of the Canada Laurentian is of organic origin, and shows that the amount of "graphite in the Lower Laurentian series is enormous." A limestone in the town of Buckingham on the Ottawa, which is 600 feet or more thick, with some 3 intercalated bands of gneiss, is in some parts *one-fourth* graphite, and the whole is not less than 20 or 30 per cent. graphite. In the adjoining township of Lochabar, a band of limestone 25 to 30 feet thick is so reticulated with graphite that it is mined for it; and another bed in the same district, 10 or 12 feet thick, yielding 20 per cent. of the pure material, is worked. It occurs in equal abundance at other horizons through beds of limestone, which have, according to Logan, an aggregate thickness of 3,500 feet. In view of the facts Dr. Dawson adds: "It is scarcely an exaggeration to maintain that the quantity of carbon in the Laurentian is equal to that in similar areas of the Carboniferous systems."

After describing the mode of occurrence and discussing the probable vegetable origin of the graphite, Dr. Dawson concludes as follows: —

"We may sum up these facts and considerations in the following statements: First, that somewhat obscure traces of organic structure can be detected in the Laurentian graphite; secondly, that the general arrangement and microscopic structure of the substance corresponds with that of the carbonaceous and bituminous matters in marine formations of more modern date; thirdly, that if the Laurentian graphite has been derived from vegetable matter, it has only undergone a metamorphosis similar in kind to that which organic matter in metamorphosed sediment of later age has experienced; fourthly, that the association of the graphite matter with organic limestone, beds of iron ore, and metallic sulphides, greatly strengthens the probability of its vegetable origin; fifthly, that when we consider the immense thickness and extent of the Eozoonal and graphite limestones and iron ore deposits of the Laurentian, if we admit the organic origin of the limestone and graphite, we must be prepared to believe that the life of that early period, though it may have existed under low forms, was most copiously developed, and that it equalled, perhaps surpassed, in its results, in the way of geological accumulation, that of any subsequent period.

"In conclusion, this subject opens up several interesting fields of chemical, physiological, and geological inquiry. One of these relates to the conclusions stated by Dr. Hunt as to the probable existence of a large amount of carbonic acid in the Laurentian atmosphere, and of much carbonate of lime in the seas of that period, and the possible relation to the abundance of certain low forms of plants and animals. Another is the comparison, already instituted by Professor Huxley and Dr. Carpenter, between the conditions of the Laurentian and those of the deeper parts of the modern ocean. Another is the possible occurrence of other forms of animal life than *Eozoon* and *Annelids*, which I have stated, in my paper of 1864, after extensive microscopic study of the Laurentian limestone, to be indicated by the occurrence of calcareous fragments, differing in structure from *Eozoon*, but at present of unknown nature. Another is the effort to bridge over, by further discoveries similar to that of the *Eozoon bavaricum* of Gümbel, the gap now existing between the life of the Lower Laurentian and that of the Primordial Silurian or Cambrian period. It is scarcely too much to say that these inquiries open up a new world of thought and investigation, and hold out the hope of bringing us into the presence of the actual origin of organic life on our planet, though this may perhaps be found to have been Prelaurentian. I would here take the opportunity of stating that in proposing the name *Eozoon* for the first fossil of the Laurentian, and in suggesting for the period the name "Eozoic," I have by no means desired to exclude the possibility of forms of life which may have been precursors of what is now to us the dawn of organic existence. Should remains of still older organisms be found in those rocks now known to us only by pebbles in the Laurentian, these names will at least serve to mark an important stage in geological investigation. — *Amer. Jour. Science*, L. (1870), *pp*. 130-132.

LAURENTIAN ROCKS OF EASTERN MASSACHUSETTS.

The investigations of Hall, Logan, and Cooke, in the Highlands of New York and New Jersey, have left no doubt that the limestones which were formerly supposed to be altered Silurian rocks are really of Laurentian age. At the meeting of the American Association for the Advancement of Science, at Salem, in 1869, the view was advanced by Sterry Hunt that the same might be the case with the similar rocks of Eastern Massachusetts. Dr. Hunt showed that this was probable, not only on lithological grounds, but also from the fact that the Laurentian rocks appear to the southward of the great palæozoic basin in New Brunswick and Newfoundland, which are geologically but a north-eastern prolongation of New England, and, moreover, from the outcropping of the lowest Silurian strata at Braintree near Boston. Subsequent microscopical examination revealed the presence of the Eozoon Canadense in a serpentinic limestone from Newburyport, and better specimens were obtained about 28 miles southwest of Newburyport, in the limestone quarries of Chelmsford.

The continuous and complete calcareous skeleton of the fossil does not appear in these specimens, which seem, like some portions of the rock from Grenville, as described by Sir William E. Logan, to be made up of fragments of the calcareous shells of the Eozoon, mingled with grains of serpentine, and cemented by crystallized carbonate of lime. In the specimens from Grenville, and from most other localities, the mineral matter replacing the sarcode and filling up the canals and tubuli of the calcareous Eozoon skeleton is generally serpentine, or some other silicate. In the Chelmsford specimens, however, the injected mineral is like the shell itself carbonate of lime, though readily distinguishable from it by difference in texture and transparency. In this connection it should be said that the crystalline rocks of Newburyport and Salisbury, although separated, in Hitchcock's geological map, from the gneisses to the south-west, and united to the sienites of Gloucester and Rockport, seem very unlike the latter, and closely related lithologically to the gneiss of Chelmsford, which encloses the crystalline limestone. — *Amer. Jour. Science, January*, 1870, *p*. 76.

THE WHITE MOUNTAINS.

At the Troy meeting of the American Association, Professor C. H. Hitchcock, of the New Hampshire State Geological Survey, exhibited an interesting model of the White Mountains, made from data obtained by a careful examination of the group by himself and his assistants. The model was made of superimposed layers of thin pine wood, of equal thickness, each thickness representing 500 feet, the whole thus displaying to advantage the *contour lines* obtained in the survey. The outcrops of the various rock formations were indicated by appropriate colors. Prof. Hitchcock advanced certain views with regard to the anticlinal or synclinal character of the ridge, which were at variance with the generally received ideas. Mt. Washington has been regarded as synclinal in structure, but Professor Hitchcock regards it as an inverted anticlinal. One of the points on which he bases this opinion is the fact that on the eastern side of the mountain occur strata which for some distance follow in their dip the slope of the mountain and then suddenly dip away into the mountain. If the professor's views as to the anticlinal structure be correct, it will be necessary to suppose that the folding force came from the land side and not from the ocean.

In connection with the State Geological Survey of New Hampshire, a party of scientific men are spending the winter (1870–71) on the top of Mt. Washington, to make various meteorological observations.

Local Glaciers of the White Mountains. — At the Troy meeting of the American Association a paper by Professor Agassiz on this subject was read by Professor Perry. Agassiz said that in 1847 he had noticed unmistakable evidence of the former existence of local glaciers in the White Mountains of New Hampshire, but that he had had no opportunity to make a careful examination of the ground until the present summer (1869). He now asserts that the drift so called has the same general characteristics on the northern and southern sides of the White Mountains, and that whatever, therefore, may have been the number of its higher peaks which at any given time, during the glacial period, rose above the great ice-sheet which then covered the country, this mountain range offered no obstacle to the southward movement and progress of the northern ice-fields.

After describing the characteristic marks of glacial action and the various kinds of *moraines*, and showing that the typical drift was one *ground moraine*, he says: —

"It is the contact of the more limited phenomena of the local glaciers which succeeded this all-embracing winter (their lateral, frontal, median, and limited ground moraines and their erratics), with the more wide-spread and general features of the drift, that I have been able to trace in the White Mountains this summer. The limits of this paper will not allow me to do more than record the general facts, but I hope to give them hereafter more in detail and with fuller illustrations. The most difficult part of the investigation is the tracing of the erratics to their origin; it is far more intricate than the identification of the origin of ordinary drift, or of continuous moraines, because the solution of the problem can only be reached under favorable circumstances where boulders of the same kind of each can be followed, from distance to distance, to the ledge *in situ* from which they were detached. Now, in the neighborhood of the White Mountains we find, beside the typical or northern drift, large erratic boulders, as well as lateral, frontal, and median moraines. A careful examination of these shows beyond a doubt that they came from the White Mountains, and not from the northern regions, since they overlie the typical drift which they have only here and there removed or modified. A short description of the facts will leave no doubt upon this point.

"The finest lateral moraines in these regions may be seen along the hill-sides flanking the bed of the south branch of the Amonoosuc, north of the village of Franconia. The best median moraines are to the east of Picket Hill and Round Hill. These latter moraines were formed by the confluence of the glaciers which occupied the depression between Haystack and Mt. Lafayette, and that which descended from the northern face of Lafayette itself. These longitudinal moraines are particularly interesting as connecting the erratic boulders on the north side of the Franconia range with that mountain mass, and showing that they are not northern boulders transported southwards, but boulders from a southern range transported northwards. But by far the most significant facts showing the great extent of the local glaciers of the White Mountain range, as well as the most accessible and easily recognized, even by travellers not very familiar with glacial phenomena, are the terminal moraines to the north of Bethlehem village, between it and the northern bend of the Amonoosuc River. The lane starting from Bethlehem Street, following the cemetery for a short distance, and hence trending northwards, cuts 16 terminal moraines in a tract of about 2 miles. Some of these moraines are as distinct as any I know in Switzerland. They show unmistakably by their form that they were produced by the pressure of a glacier moving from south northwards. This is indicated by their abrupt southward slope, facing, that is, toward the Franconia range, while their northern face has a much gentler descent. The steeper slope of a moraine is always that resting against the glacier, while the outer side is comparatively little inclined. The form of these moraines, therefore, as well as their position, shows that they have come down from the Franconia Mountains."

After describing in detail the various local phenomena of glacial action in the various places in which they occur, he proceeds: —

"All these moraines and traces of local glaciers overlie the typical or northern drift so-called, wherever the latter has not been entirely swept away by the local glaciers themselves; thus showing that the great ice-sheet is anterior to the local glaciers, and not formed by a spreading of smaller pre-existing glaciers. At least, wherever I have recognized traces of circumscribed glaciers in regions where they no longer exist, it has always appeared to me that the minor areas covered by ice were remnants of a waning sheet of greater extent. If the glacial period set in by the enlargement of limited glaciers already formed and gradually spreading more and more widely, as Lyell and the geologists of his school suppose, the facts which would justify such a view are still to be made known. I have not seen a trace of them anywhere. On the contrary, throughout the ranges of the Alps, in the Black Forest, the Vosges as well as the British Islands, in Scotland, Wales, and Ireland, I have everywhere satisfied myself that the more extensive the glaciated areas, indicated by polished surfaces and moraines in any given locality, the older they are when compared with glacial phenomena circumscribed within narrower limits. It therefore follows, from the facts enumerated above, as well as from a general consideration of the subject, that the local glaciers of the White Mountains are of more recent date than the great ice-sheet which fashioned the typical drifts. On another occasion I hope to show that the action of the local glaciers of the White Mountains began to be circumscribed within the areas they have covered, after the typical drift had, in consequence of the melting of the northern ice-sheet, been laid bare in the Middle States, in Massachusetts and Connecticut, after even the southern portions of Vermont, New Hampshire, and Maine had been freed, and when the White Mountains, the Adirondacks, and the Katahdin range were the only ice-clad peaks in this part of the continent.

"When in their turn the glaciers of the White Mountain region began to melt away, the freshets occasioned by the sudden large accumulation of water remodeled many of these moraines and carried off the minute materials they contained, to deposit them lower down in the shape of river terraces. I have recently satisfied myself, by a careful examination, that all the river terraces of the Connecticut River valley and its tributaries, as well as those of the Merrimac and its tributaries, are deposits formed by the floods descending from the melting glaciers. What President Hitchcock has described as sea-beaches and ocean-bottoms near the White Mountain and Franconia Notches, as well as in the Connecticut River valley and along the Merrimac, have all the same origin. The ocean never was in contact with these deposits, which nowhere contain any trace of marine organic remains."

IRON SAND ORES.

In a paper before the American Association for the Advancement of Science, Dr. T. Sterry Hunt said the presence of black iron sand upon many sea-beaches' has long been noticed both in Europe and America. Their origin is to be found in the crystalline rocks, from the disintegration of which these sands have been derived. The action of the waves, by virtue of the greater specific gravity of these sands, effects a process of concentration, so that considerable layers of nearly pure black sand are often found on shores exposed to wind and tide. These black sands vary in composition according to the localities, but as found on the coast of New England and the Gulf of St. Lawrence consist of magnetic oxide of iron, with a large admixture of titanic iron ore, and more or less garnet, the purest specimens holding from 30 to 50 per cent. of magnetic grains. Such sands have long been employed as sources of iron in India, in small furnaces where they are directly converted into malleable iron. Early in the last century the considerable quantities of these sands found on our Atlantic coast attracted the attention of the colonists and of scientific men in England, and the Virginia sand-iron, as it was called, was the subject of many experiments. The first successful attempts at working it were, however, made in Killingworth, Conn., where the Rev. Jabez Elliot, grandson of the celebrated John Elliot, the apostle of the Indians, early turned his attention to the abundant black sands of the coast, and succeeded in treating them in a forge fire similar to the German forge of the modern American bloomary fire. It appears from his account laid before the Royal Society of London, in 1761, that he was then making iron blooms of 50 pounds' weight from this ore, and that his son had already established a steel factory in Killingworth, when an act of the British Parliament forbade the manufacture of steel in the colonies. The London Society of Arts in 1761 awarded a medal to Mr. Elliot for his discovery. The working, however, was abandoned, and for a century no attempts were made in America to use these sands. Some 4 years since the large quantities of them in the lower St. Lawrence attracted attention, and successful trials were made for their reduction in the bloomary fires of Northern New York, after which an establishment for working them was erected at Morsie, in the Gulf of St. Lawrence, where, under the direction of skilled workmen from Lake Champlain, the treatment of these iron sands has been successfully carried on. These sand ores are remarkably free from both sulphur and phosphorus, and hence yield an iron of great purity and toughness. The working is effected in furnaces like those used on Lake Champlain, and presents no difficulties.

THE PHOSPHATE BEDS OF SOUTH CAROLINA.

The following extract is from a paper read before the Boston Society of Natural History, by Prof. N. S. Shaler: —

"The bed of phosphate of lime lies immediately on the top of the 'marls of the Ashley and Cooper Rivers,' as they have been generally termed, though these beds are not limited to the basins of these streams. The whole of the workable material lies in a single bed, from 6 inches to 3 feet in thickness. Although it varies in its chemical and fossil components, it retains everywhere certain marked features. It is always more or less nodular; the nodules vary much in size, some being no larger than a pea, some a foot or more in diameter. These nodules contain, generally, one or more fragments of shells or corals, apparently all Eocene species, which seem to have been the aggregating points of the matter contained in the nodule. So far as my knowledge goes, there have been few, if any, nodules found containing traces of vertebrate remains. Many of the nodules show traces of wearing, not exactly what would be expected from their being rolled as by a stream, but the style of wear which comes from being *stamped* and trodden on. The appearance of the worn surfaces *reminds* me of that seen on fragments of bone from Big Bone

Lick, which have been ground by the trampling of the large pachyderms and ruminants which frequented that swamp. Sometimes these nodules do not make up more than a considerable fraction of the bed, the remainder being sand, pebbles, or the marl of the character found on the bed beneath. Again, the nodules are so crowded in the bed that they are soldered together into one mass, with scarce any interspaces between the separate concretions.

"Mingled with the concretions there is found a very variable quantity of fossil vertebrate remains; by far the greater part of these consist of exceedingly worn fragments of cetacean bones and sharks' teeth and vertebræ, both clearly of the same species as those found lower down in the marls in the same section. Mingled with these, but comparatively rarely found, are the bones of a fossil horse, pig, mastodon, and bones and utensils of man. These last-named fossils are almost always in a state of preservation, widely different from that of the remains of the cetaceans and selachians with which they are mingled. Their appearance indicates a comparatively recent inhumation.

"Chemical analysis shows us that the nodules of this deposit contain the greatest quantity of phosphate of lime, the quantity varying at different points from 40 to nearly 70 per cent. The first and most natural seeming explanation of the large amount of this salt is, that it is derived from the bones and excrements of the animals whose remains are found in the bed. But the points where the most bones are found are not those where the phosphate deposit is thickest or richest. At Chisholm's Island, on the waters of St. Helena Sound, where the bed has the greatest development yet discovered, and where the analysis shows more phosphoric acid than at some of the localities the richest in bones, the remains of vertebrate animals are very rarely found. It is not too much to say that at this locality not 1 part in 10,000 of the mass is composed of vertebrate remains. Nor can we assume that the mass of phosphoric acid has been furnished by the decay of bones which have been utterly broken down; in that case we should have the remaining bones showing all degrees of preservation. This, however, is not the case; the fragments, though usually much worn, retain their structure very well. Although I went upon the ground with a disposition to regard the beds as the result of the decay of vertebrate remains, the general character of the deposit soon compelled me to seek some other explanation of its origin.

"It has been suggested by a distinguished chemist, that the deposit was the result of the submergence of a great guano area, during which submergence the bones of marine animals became mingled with the mass. There are several objections to this view: in the first place, no remains of birds have been found in the deposit, though fossils quite as likely to be destroyed are well preserved there. Then it is difficult to see how in the immediate past this swampy shore could have been the breeding-place of the quantities of birds which would have been required to have accumulated these phosphates, nor could we suppose that the climate of this shore could have been at the time of the deposition of the phosphates so different from what it is at present, as would have been required to produce the dry conditions essential to the accumulation of a guano deposit.

"There is another view of the origin of these phosphate beds, which, so far as my knowledge goes, has not yet been suggested, and which, it seems to me, solves a part of the difficulties.

"The phosphate layer rests upon a mass of marl containing a number of fossils which are found in a worn condition mingled with the phosphate nodules. The analyses of Dr. St. Julien Ravenel have shown that at several points beneath the phosphate beds the marl contains several per cent. of phosphate of lime, and it may be assumed as eminently probable that the whole of the marl beneath the region where the phosphate beds occur contains a certain quantity of this material, mingled with the carbonate of lime which constitutes the mass. Now it is a well-known fact that water containing carbonic-acid gas in solution has a solvent action upon both these salts of lime, but that its power is greatest on the carbonate of lime. So that a mass of marl containing both these materials, submitted to the action of water charged with carbonic acid, might have the carbonate of lime entirely removed, and the mass left behind when the solvent action ceased might consist almost altogether of the phosphate of lime.

"If we look a moment at the conditions which prevail in the phosphate region, we shall see that with this view we can easily frame an explanation of the formation of this phosphate layer. The usual section through these beds gives us on top a layer of vegetable matter and soil containing humus, through which the water percolating becomes charged with carbonic acid; then the phosphate layer; immediately beneath that the marl containing phosphates, which is only slightly permeable to water. Soaking over this marl the water becomes charged with carbonate of lime and some phosphate, which it carries away in the drainage system of the country. This process, going on for centuries, gradually dissolves away a great thickness of the marl, and gives, as in the capping bed, an accumulation made up of fossils from the wasted beds, which resisted decay, and could not be washed away; of phosphates which became aggregated into nodules; of remains of man and other recent animals, which, falling in the swamp, sank through the soft bog and became trampled in among the nodules by the living animals which inhabited this low land.

"Great freshets might lay down several feet of clay and sand or some rearranged marl on top of the phosphate layer, thus confusing the record, by making the remains of man and extinct animals associated with his early history in this region seem a part of the ancient marl beds.

"Looking upon the phosphate layer as the débris of a large amount of eroded marl, it is no longer a difficult matter to account for the association of fossils found there, which would be inexplicable without some theory of this kind."

As to the manner of accounting for the presence of phosphoric acid in the marls in such quantity and so regularly disseminated, Prof. Shaler says that no perfectly satisfactory explanation has yet been offered. He seems, however, to incline towards an hypothesis similar to that offered by Sterry Hunt to account for the massive apatite beds of the early palæozoic rocks; namely, the action of quantities of unarticulated brachiopods separating phosphate of lime from the waters of the sea. In this connection he says:—

"We know that some of the pteropod mollusks, forms which are frequently abundant in the ocean at great distances from the land, have a composition not materially different from that of bones. It has even been stated, though I do not yet know by what authority, that some of the marine algæ contain a large per cent. of phosphate of lime. The fact of the existence of this material in a number of the inferior organizations of the sea makes it, in most cases, more reasonable to account for the formation of extensive masses of phosphate beds by the deposition of the remains of invertebrate species, than to suppose that they were accumulated by vertebrate animals." — *Proc. Boston Soc. Nat. Hist.*

SURFACE GEOLOGY OF THE BASIN OF THE GREAT LAKES.

Dr. Newberry, in a paper on the "Surface Geology of the Basin of the Great Lakes and the Valley of the Mississippi," says:—

"The most important facts which the study of the *drift phenomena* of this region have brought to light are briefly as follows:—

"1st. In the northern half of this area down to the parallels of 38°–40° we find not everywhere, but in most localities where the nature of the underlying rock is such as to retain inscriptions made upon them, the upper surface of these rocks planed, furrowed, or excavated in a peculiar and striking manner. No one who has seen glaciers, and noticed the effect they produce on the rocks over which they move, will fail to pronounce these markings the tracks of glaciers. Though having a general north-south direction, locally the glacial furrows have very different bearings, conforming in a rude way to the present topography, and following the direction of the great lines of drainage.

"2d. Some of the valleys and channels which bear the mark of glacial action are excavated far below the present lakes and water-courses which occupy them. These valleys form a connected system of drainage at a lower level than the present river system, and lower than could be produced without a continental elevation of several hundred feet." As examples of this Dr. Newberry cites among others the following: An old excavated, now-filled channel, connects Lakes Erie and Huron, the rock surface at Detroit being 130 feet below the city; an excavated trough runs south from Lake Michigan, penetrated at Bloomington, Ill., to the depth of 230 feet; the rock bottoms of the troughs of the Mississippi and Missouri near their junction, or below, have never been reached. The borings for oil in the valleys of the western rivers have afforded opportunity for demonstrating the existence of buried channels of excavation, and sometimes data enough from which to map them out. Many other similar instances might be adduced.

"3d. Upon the glacial surface we find a series of unconsolidated materials, generally stratified, called the *drift deposits.*

"4th. Above the Erie clays are sands of variable thickness and less widely spread than the underlying clays.

"5th. Upon the stratified clays, sand, and gravel are scattered boulders and blocks of various sizes of metamorphic and eruptive rocks, generally traceable to some locality north of the lakes.

"6th. Above all these drift deposits, and more recent than any of them, are the lake ridges, embankments of sand, gravel, etc., which run imperfectly parallel to the present outlines of the lake margins.

"The history which I derive from the facts cited above is briefly this:—

"1st. That in a period probably synchronous with the glacial epoch of Europe,—at least corresponding to it in the sequence of events,—the northern half of the continent of North America had a climate comparable with that of Greenland; so cold that wherever there was a copious precipitation of moisture from oceanic evaporation, that moisture was congealed, and formed glaciers, which flowed by various routes towards the sea.

"2d. That the courses of these ancient glaciers corresponded in a general way with the present channels of drainage. The direction of the glacier furrows proves that one of the ice-rivers flowed from Lake Huron, along a channel now filled with drift and known to be at least 150 ft. deep, into Lake Erie, which was then not a lake, but an excavated valley, into which the streams of Northern Ohio flowed 100 feet or more below the present lake level. Following the line of the major axis of Lake Erie to near its eastern extremity, here turning north-east, this glacier passed through some channel on the Canadian side, now filled up, into Lake Ontario, and thence found its way to the sea, either by the St. Lawrence, or by the Mohawk and Hudson. Another glacier occupied the bed of Lake Michigan, having an outlet southward through a channel,—now concealed by the heavy beds of drift which occupy the surface about the south end of the lake,—passing near Bloomington, Ill., and, by some route yet unknown, reaching the trough of the Mississippi, which was then much deeper than at present.

"3d. At this period the continent must have been several hundred feet higher than now, as is proved by the deeply excavated channels of the Columbia, Golden Gate, Mississippi, Hudson, etc., which never could have been cut by the streams now occupying them unless flowing with greater rapidity and at a lower level than they now do."

With regard to the surface boulders, Dr. Newberry says:—

"There is indeed no other conclusion deducible from the facts than that these sands, gravels, greenstone and other boulders have been *floated* to their resting-places, and that the floating agent has been ice in the form of icebergs; in short, that these materials have been transported and scattered over the bottom and along the south shore of our ancient inland sea, just as similar materials are now being scattered over the banks and shores of Newfoundland.

"These boulders include representations of nearly all the rocks of the Lake Superior country, conspicuous among which are granites with rose-colored orthoclase, gray gneiss and diorites, all characteristic of the Laurentian series; hornblendic rocks, massive and schistose, and dark greenish or bluish silicious slates, probably from the Huronian dolorites, and masses of native copper, apparently from the Keweenaw Point copper region.

"In the drift gravels I have found pebbles and small boulders of nearly all the palæozoic rocks of the lake basin containing their characteristic fossils, namely, Calciferous sandstone with *Maclurea;* Trenton and Hudson with *Ambonychia radiata*, *Cyrtolites ornatus;* Medina with *Pleurotomaria litorea;* Corniferous with *Conocardium trigonale*, *Atrypa reticularis*, *Favosites polymorpha;* Hamilton with *Spirifer mucronatus*, etc."

In remarks on the origin of the great lakes, Dr. Newberry states, as "facts and deductions:"—

"1st. Lake Superior lies in a synclinal trough, and its mode of formation therefore hardly admits of question, though its sides are deeply scored with ice-marks, and its form and area may have been somewhat modified by this agent.

"2d. Lakes Huron, Michigan, Erie and Ontario are excavated basins, wrought out of once continuous sheets of sedimentary strata by a mechanical agent, and that ice or water or both."—*Annals Lyceum Natural History, New York*, 1869.

POST-TERTIARY PHENOMENA.

Prof. Winchell, of the Michigan Geological Survey, read a paper at the Troy meeting of the American Association for the Advancement of Science upon the Post-Tertiary Phenomena in Michigan. The paper, he said, was intended simply to make note of three classes of phenomena recently observed in Michigan. The first note was in reference to the relics found in and beneath the numerous peat-beds of the State. These beds are the sites of ancient lakelets that have been slowly filled by the accumulation of sediments. They enclose numerous remains of the mastodon and mammoth. These are sometimes found so near the surface that one could believe they have been buried within 500 or 1,000 years. For the first time, too, the remains of the gigantic extinct beaver of North America have been recently found in Michigan. What is perhaps most interesting of all is the discovery of a flint arrow-head in a similar situation. This arrow-head was found 7 feet beneath the surface, in a ditch excavated in the southern part of Washtenaw County. The mastodon remains found near Tecumseh, but a few miles distant, lay but 2½ feet beneath the surface. The Adrian mastodon was buried but 3 feet deep.

The second note made related to the occurrence of enormous beds of bog-iron ore in the upper peninsula of Michigan, on the tributaries of the Monistique River. It occurs in a half-desiccated bog covering several townships. It is of remarkable purity, and great but unknown depth. It lies directly in the track of the projected railroad intended to connect the Northern Pacific Railroad with the railroad system of Michigan. The ore can be floated down the Monistique and its tributaries to Lake Michigan, in the immediate vicinity of an excellent harbor. This immense deposit is undoubtedly derived from the disintegration of the hematites and magnetites of the contiguous region on the west. The ore will possess great value for mixing with the other Lake Superior ores.

The third note made was on the discovery of an ancient outlet of Lake Superior. Following the White Fish River from the head of Little Bay de Noc, we find it occupying a broad and deep valley, walled in on both sides by limestone cliffs attaining an elevation of 120 feet. The head-waters of this river literally interlace with those of the Au Train River, which runs north into Lake Superior. Here is a vast valley of erosion but little elevated in any part above the present level of Lake Superior. Through this the waters of that lake must have flowed in a powerful stream in that earlier epoch when all the lakes stood from 50 to 300 feet higher than at present. There are many evidences of glacier action along this valley. The striæ at Marquette, near the head of the valley, point north and south. In short, the evidences lead to the conviction that a vast glacier stream once traversed this valley, and was probably the agency by which it was excavated. Little Bay de Noc is but the prolongation of this valley at a lower level; and, indeed, the whole basin of Green Bay seems to be but a phenomenon of erosion belonging to the epoch of the same glacier system.

THE MAUVAISES TERRES IN COLORADO.

Prof. Marsh, in a letter to Prof. Dana, dated Aug. 12, 1870, says: —

"The scientific expedition from Yale College, while recently examining the geology of northern Colorado, discovered an extensive outcrop of the true Mauvaises Terres, or White River formation, at a point nearly 200 miles south of the region where it had been previously identified. The locality first detected, which contained all the characteristic fossils of this deposit, was on one of the branches of the Little Crow Creek, about 5 miles south of the Wyoming State line. The strata there observed consisted of at least 150 feet of light-colored clays, overlaid by conglomerates and sandstones about 200 feet in thickness. The lower portions of the clays are the true *Titanotherium* beds, containing many remains of the Titanotherium Proutii. Above these are similar clay deposits, corresponding closely in age with those on the White River, and marked by abundant remains of *Oreodon Culbertsoni*, *Testudo Nebrascensis*, *Helix Leidyana*, and many other fossils which characterize that horizon. Associated with these were found several new species of mammals and birds.

"This interesting series of fresh-water tertiary strata lies almost horizontal, dipping apparently, but very slightly, towards the north-east. It probably forms the south-west border of the great Miocene Lake Basin east of the Rocky Mountains, which is so remarkable for its extinct animal remains. Our party traced the same formation with its more common fossils about 30 miles north-east into Wyoming, along the hills known as Chalk Bluffs, and still farther north in the Pine Bluff range."—*Amer. Jour. Science, September*, 1870.

GOLD AND SILVER MINES OF COLORADO.

The gold and silver lodes of this territory, so far as they are observed, are entirely composed of the gneissic and granitic rocks, possibly of the age of the Laurentian series of Canada. At any rate, all the gold-bearing rocks about Central City are most distinctly gneissic, while those containing silver, at Georgetown, are both gneissic and granitic. The mountains in which the Baker, Brown, Coin, Terrible, and some other rich lodes are located is composed mostly of gneissic and reddish feldspathic granite, while the Leavenworth and McClellan Mountains, equally rich in silver, are composed of banded gneiss with the lines of bedding or stratification very distinct.

There is an important question that suggests itself to one attempting to study the mines of Colorado, and that is the cause of the wonderful parallelism of the lodes, the greater portion of them taking one general direction or strike, north-east and south-west. We must at once regard the cause as deep-seated and general, for we find most of the veins or lodes are true fissures, and do not diminish in richness as they are sunk deeper into the earth. All these lodes have more or less clearly defined walls, and some of them are quite remarkable for their smoothness and regularity. We assume the position that the filling up of all these lodes or veins with mineral matter was an event subsequent to any change that may have occurred in the country rock. Now, if we look carefully at all the azoic rock in this region, we shall find more or less distinctly defined, depending upon the structure of the rock itself, two planes of cleavage, one of them with a strike north-east and south-west, and the other south-east and north-west. Besides these two sets of cleavage planes, there are in most cases distinct lines of bedding. The question arises, What relation do these veins hold to these lines of cleavage? Is it not possible that they occupy these cleavage openings in lines of greatest weakness?

I have taken the direction of these two sets of cleavage planes many times with a compass, over a large area, and very seldom do they diverge to any great extent from these two directions, north-east and south-west or south-east and north-west. In some instances the north-west and south-east plane would flex around so as to strike north and south, and the other one so as to trend east and west; but this is quite seldom, and never occurs unless there has been some marked disturbance of the rocks. There are, however, a few lodes which are called "east and west lodes," and some "north and south." A few have a strike north-west and south-east, but are generally very narrow andbreak off from the north-east and south-west lodes, are very rich for a time, and then *pinch* out. It would seem, therefore, quite possible that the north-east and south-west veins took the lines of cleavage in that direction as lines of greatest weakness, and that the north-west and south-east lines cross the other set, and that a portion of the mineral matter might accumulate in that cleavage fissure. I merely throw out this as a hint at this time which I wish to follow out in my future studies. I am inclined to believe that the problem of the history of the Rocky Mountain ranges is closely connected with these two great sets of cleavage lines. As I have before stated, my own observations point to the conclusion that the general strike of the metamorphic ranges of mountains is north-west and south-east, and that the eruptive trend north-east and south-west. The dikes, that sometimes extend long distances across the plains, in all cases trend north-east and south-west, or, occasionally, east and west. The purely eruptive ranges of the northern portion of the San Luis Valley seem to be composed of a series of minor ranges *en échelon* with a trend north-east and south-west. But as soon as this range joins on to a range with a metamorphic or granitic nucleus, the trend changes around to north-west and south-east. Many of the ranges have a nucleus of metamorphic rocks, though the central and highest portions may be composed of eruptive peaks and ridges. In this case the igneous material is thrust up in lines of the same direction as the trend. It becomes, therefore, evident that all the operations of the eruptive forces were an event subsequent to the elevation of the metamorphic nucleus. This is shown in hundreds of instances in Colorado and New Mexico, where the eruptive material is oftentimes forced out over the metamorphic rocks, concealing them over large areas.

All over the mining districts are well-marked anticlinal, synclinal, and what I have called monoclinal valleys. Nearly all the little streams flow a portion or all their way through these monoclinal valleys or rifts. In most cases the streams pass along these rifts from source to mouth, but occasionally one bursts through the upheaved ridges at right angles, and resumes its course again in some monoclinal opening.

In these valleys are oftentimes accumulated immense deposits of modern drift. The upper side of this drift deposit is fine sand, but the materials grow coarser as we descend, until, at the lower side, there are immense irregular or partially worn masses of granite. On the sides of the valley the rocks are often much smoothed and grooved as if by floating masses of ice. We assume the position, of which there is most ample evidence all over the Rocky Mountain region, that at a comparatively modern geological period the temperature was very much lower than at present, admitting of the accumulation of vast bodies of ice on the summit of the mountains. The valley of the South Platte, as that stream flows through the range east of the South Park, show not only these accumulations of very coarse boulder drift, but, when this drift is stripped off, the underlying rocks are found smoothed and in some instances scratched as if by floating icebergs. — *F. V. Hayden, in the Preliminary Field-Report of the U. S. Geological Survey of Colorado and New Mexico, Washington,* 1869, *page* 87.

VALLEY OF THE RIO GRANDE.

The broad intermediate space between the range of mountains which form the east side of the Valley of the Rio Grande and the Sierra Madre — a main range of the Rocky Mountains, which gives origin to the waters of the Pacific streams — is covered with rounded hills, detached ranges, etc., all of which are basaltic. The two rounded hills, which are very marked, situated nearly opposite to each other on opposite sides of the Rio Grande, Cerro de la Utas, and Cerro San Antonio, are, it seems to me, old craters or fissures out of which issued the melted material which overflowed the sides, and time has weathered the whole mass into its present beautiful rounded form. At this time they look like gigantic mammæ.

I am inclined to regard the Valley of the Rio Grande as one great crater, including within its rim a vast number of smaller craters and dikes, out of which has been poured at some time a continuous sheet or mass of melted material. All the valleys, small and great, give evidence that they have been worn out of this vast mesa. The Rio Grande, from its source in the San Juan Mountains to Albuquerque, flows along its banks through basaltic rocks to a greater or less extent, and as we go northward from it these rocks disappear in part. — *F. V. Hayden, ibid., p.* 72.

GEOLOGY OF THE VALLEY OF THE AMAZONS.

The following paragraph, with reference to the sandstones and clays of the Valley of the Amazons,* is taken from Agassiz' Journey in Brazil: —

"The question now arises, How were these vast deposits formed? The easiest answer, and the one which most readily suggests itself, is that of a submersion of the continent at successive periods to allow the accumulation of these materials, and its subsequent elevation. I reject this explanation for the simple reason that the deposits show no sign whatever of a marine origin. No sea-shells, nor remains of any marine animal, have as yet been found throughout their whole extent over a region several thousand miles in length, and from 500 to 700 miles in width. It is contrary to all our knowledge of geological deposits to suppose that an ocean basin of this size, which must have been submerged during an immensely long period in order to accumulate formations of such a thickness, should not contain numerous remains of the animals formerly inhabiting it. The only fossil remains of any kind truly belonging to it, which I have found in the formation, are leaves taken from the lower clays on the banks of the Solimões at Tonantins; and these show a vegetation similar in general character to that which prevails there to-day. Evidently, then, this basin was a fresh-water basin; these deposits are fresh-water deposits. But as the Valley of the Amazons exists to-day, it is widely open to the ocean in the east, with a gentle slope from the Andes to the Atlantic, determining a powerful seaward current. When these vast accumulations took place the basin must have been closed; otherwise the loose materials would constantly have been carried down to the ocean. It is my belief that all these deposits belong to the ice-period in its earlier or later phases, and to this cosmic winter, which, judging from all the phenomena connected with it, may have lasted for thousands of centuries, we must look for the key to the geological history of the Amazonian Valley." . . . "Is it so improbable that in this epoch of universal cold the Valley of the Amazons also had its glacier poured down into it from the accumulations of snow in the Cordilleras, and swollen laterally by the tributary glaciers descending from the table-lands of Guiana and Brazil? The movement of this immense glacier must have been eastward; determined as well by the vast reservoirs of snow in the Andes as by the direction of the valley itself. It must have ploughed the valley bottom over and over again, grinding all the materials beneath it into a fine powder, or reducing them to small pebbles, and it must have accumulated at its lower end a moraine of proportions as gigantic as its own; thus building a colossal sea-wall across the mouth of the valley. I shall be asked at once whether I have found here also the glacial inscriptions, — the furrows, striæ, and polished surfaces so characteristic of the ground over which glaciers have travelled. I answer, not a trace of them; for the simple reason that there is not a natural rock surface to be found throughout the whole Amazonian valley. The rocks themselves are of so friable a nature, and the decomposition caused by the warm torrential rains and by exposure to the burning sun of the tropics so great and unceasing, that it is hopeless to look for marks which in colder climates and on harder substances are preserved through ages unchanged. With the exception of the rounded surfaces, so well known in Switzerland as the *roches moutonnées*, which may be seen in many localities, and the boulders of Ereré, the direct traces of glacial action as seen in other countries are wanting in Brazil. I am, indeed, quite willing to admit that, from the nature of the circumstances, I have not here that positive evidence which has guided me in my previous glacial investigations. My conviction in this instance is founded, first, on the materials in the Amazonian valley which correspond exactly in their character to materials accumulated in glacier bottoms; secondly, in the resemblance of the upper or third Amazonian formation to the Rio drift, of the glacial origin of which there cannot, in my opinion, be any doubt; thirdly, in the fact that these fresh-water basins must have been closed against the sea by some powerful barrier, the removal of which would naturally give an inlet to the waters, and cause the extraordinary denudations, the evidences of which meet us everywhere throughout the valley."

---

* For the views of Prof. Agassiz on the Geological History of the Valley of the Amazons see the Journey in Brazil, by Prof. and Mrs. Agassiz, Boston, 1868, p. 398 and following. See, also, "Annual of Scientific Discovery," 1867, p. 270 and following.

Professor James Orton differs from Agassiz altogether in his views of this formation. He says: —

"It is a question to what period this great accumulation is to be assigned. Humboldt called it *Old Red Sandstone;* Martius pronounced it *New Red;* Agassiz says *Drift*, — the glacial deposit brought down from the Andes and worked over by the melting of the ice which transported it. The professor further declares that 'these deposits are fresh-water deposits; they show no sign of a marine origin; no sea-shells nor remains of any marine animal have as yet been found throughout their whole extent; tertiary deposits have never been observed in any part of the Amazonian basin.' It is true that neither Bates, Wallace, nor Agassiz found any marine fossils on the banks of the great river, but these explorers ascended no farther than Tabatinga. Two hundred miles west of this fort is the little village of Pebas, at the confluence of the Ambiyacu. In the high bank on which the village stands, I discovered a fossiliferous bed interstratified with the variegated clays so peculiar to the Amazon. It was crowded with *marine tertiary shells.* The species, as determined by W. M. Gabb, Esq., of Philadelphia, are *Neritina pupa*, *Turbonilla minuscula*, *Mesalia Ortoni*, *Tellina Amazonensis*, *Pachydon (gen. nov.) obliqua*, and *Pachydon tenua.* It is a singular fact that the Neritina is now living in the West India waters, and the species found at Pebas retains its peculiar markings; so that we have some ground for the supposition that not many years ago there was a connection between the Caribbean Sea and the upper Amazon; in other words, that Guiana has only very lately ceased to be an island. Interstratified with the clay deposit are seams of a highly bituminous lignite; we traced it from near the mouth of the Curaray on the Rio Napo to Loreto on the Marañon, — a distance of about 400 miles. It occurs also at Iquitos. This is further testimony against the glacial theory of the formation of the Amazonian valley. The paucity of shells in such a vast deposit is not astonishing. It is remarkable in the similar accumulation of reddish argillaceous earth, called *Pampean mud*, which overspreads the Rio Plata region. Some of the Pampa shells, like those at Pebas, are proper to brackish water, and occur only on the highest banks. The Pampean formation is believed by Mr. Darwin to be an estuary or delta deposit."— *Orton. — The Andes and the Amazon. New York*, 1870, *page* 378 *and following; and Proceedings Amer. Assoc. Adv. Sci.*, XVIII. (1869), *pages* 195–199.

At the meeting of the American Association at Troy, 1870, Professor Orton exhibited specimens of shells which have since been found by Mr. Huxwell and others at different localities, among other places at a point on the Marañon, 30 miles below Pebas. They seem to be chiefly of species inhabiting brackish waters.

Prof. Hartt also differs from Prof. Agassiz in his interpretation of the Amazonian geology. While recognizing with him the former existence of glaciers under the tropics, he considers the clay and sandstone deposits as *tertiary* in age, and as contemporaneous with similar formations in other parts of Brazil where they are overlaid by the true drift.

BRAZILIAN GEOLOGY.

The *eozoic* rocks are represented by gneisses, of which the distribution is very general and the extent enormous. As a rule the gneiss, which on the east is coarse and porphyritic, becomes finer as one proceeds westward, and is generally overlaid by mica slates or mica-schistose gneiss. This is certainly the oldest rock formation of the Brazilian plateau. Dr. Hunt has examined a large series of rocks brought from Brazil by Prof. Hartt, and finds that they are very similar in character to the Laurentian rocks of North America. With this formation the Brazilian gneisses also agree in the presence of interstratified beds of limestone and in the absence of clay-slates. The rocks in the northern provinces have been but slightly examined, and the study of those of the southern provinces is attended with difficulty on account of the extent to which the rocks are decomposed. The exact succession of the different members of the metamorphic series lying just inside of the gneiss belt has not been satisfactorily worked out. The clay and talcose schists, the itacolumite, itaribite, and other associated metamorphic rocks of this region appear to be lower palæozoic in age. The gold-bearing rocks in Minas Geraes resemble the similar auriferous series of the southern Atlantic States, in which itacolumite occurs. The metamorphism has been so extensive that all traces of fossils have been obliterated. Most of these rocks are probably *Silurian*, although some of them may be *Devonian*.

The *carboniferous* rocks are developed to a slight extent in the southern part of Brazil, the coal-beds being a coast formation, but slightly disturbed and of a bituminous character. The triassic is represented by a series of red sandstones, lithologically identical with the Connecticut River sandstones. There is no trap associated with them as far as yet observed. The *cretaceous* rocks begin a few miles south of the Bay of Bahia, and extend at intervals along the coast to the northward. It is difficult to estimate the exact extent, as they are covered by tertiary beds. They probably underlie the tertiary deposits of the whole valley of the Amazons. The clays and ferruginous sandstones forming the coast plains overlying unconformably the cretaceous and covered by *the drift* clays, Professor Hartt refers to the *tertiary*, although no *fossils* have been found. To the same formation, though of later age, he refers the horizontal beds of clays and sandstones of the Jequitinhonha and São Francisco valley, which lie undisturbed on upheaved cretaceous rocks, and which are also covered by drift clay. These beds must have been deposited when the continent stood 3,000 feet lower than at present, the material being derived from the decomposed gneissic rocks, and deposited rapidly in a muddy sea unfit for animal life.

The next formation, which is very wide-spread, is composed of a layer of red clay, overlying as a general rule a layer of quartz pebbles, varying in degree of firmness, and occasionally there are intermingled fragments of gneiss, trap, or tertiary sandstone. This sheet of structureless clays, gravels, and boulder deposits stretching along the whole coast, and covering alike the coast tertiary plains, the elevated campus, and the serras from bottom to top, is referred by Professor Agassiz to the *drift*, and in this opinion he is sustained by Professor Hartt. All Rio de Janeiro, and all the coast provinces visited by the latter, were thus covered. It has been described in Minaes Geraes and São Paulo, and, according to Professor Agassiz, it exists in various localities on the coast, north of Pernambuco, and in the valley of the Amazons, westward to the confines of Peru. In the province of Bahia there are extensive bare, elevated rocky plains thickly strewn with angular blocks of stone, some of which are erratics and *exactly resemble the drift-covered plains of the north.* On similar elevated plains, far removed from any higher land, Mr. J. A. Allen (another member of the Thayer Expedition) found numerous deep and smooth pot-holes worn in solid gneiss. They were of various sizes, the largest seen being elliptical, 18 feet long by 10 wide and 27 feet deep. Similar pot-holes are known to be formed by glacial water-falls, and they are found over the glaciated regions of New Brunswick and Nova Scotia. Heaps of débris, exactly resembling glacial moraines in the valley of Tijuca near Rio, and Professor Agassiz has described others still more perfect in Ceara, only 4 or 5 degrees south of the equator.

Professor Hartt thus states his belief in regard to the drift deposits: "I believe that during the time of the drift the country stood at a much higher level than at present, and that it was covered by a general glacier. Over the coast region, where decomposition of the rocks had largely obtained, and where the surface of the rock, rendered even by this agent, had been covered by a thick layer of loose material, the glacier reworked this loose material, and when it disappeared left it as a paste, in which the harder materials, such as fragments from quartz veins, more or less rounded, were embedded. The layer of quartz pebbles underlying the paste appears to have consisted of coarser fragments borne along by the bottom of the glacier, while the paste seems to have been more or less distributed through the body of the glacier. In the drift paste I have never seen organic remains of any kind."

Mode of Occurrence of Diamonds. — In speaking of the diamond-washing at Pitanga, Professor Hartt says: "The diamonds appear to me to come from the tertiary beds of the neighboring hills; and this seems to be the opinion of Mr. Nicolay, who shows that the diamonds of the Chapada Diamantina came from a conglomerate and sandstone, which, from his description and specimens, appears to be a tertiary rock of the same kind as that which forms the chapadas of the valley of the Jequitinhonha. There is no itacolumite in the vicinity of Pitanga. The gravel is made up principally of fragments of quartz and of pebbles of a sandstone like that of the tertiary chapada, though somewhat harder than the kind usually seen along the road. I do not believe that the diamond ever occurs in the true palæozoic itacolumite in Brazil, but that it is derived from the tertiary sandstones." — *Thayer Expedition. Scientific Results of a Journey in Brazil, by Louis Agassiz and his Travelling Companions.* •*Geology and Physical Geography of Brazil, by Ch. Fred. Hartt, Professor of Geology in Cornell University. Boston,* 1870.

CARIBBEAN SERIES OF TRINIDAD.

Mr. Guppy, President of the Scientific Association of Trinidad, stated before the Geological Society of London, that the northern range of mountains of Trinidad is composed entirely of rocks belonging to the Caribbean formation. The section from N.N.W. to S.S.E. from the sea, through the valleys of Diego Martin, Maraval, and St. Ann, shows the following succession of rocks in ascending order: —

(1) Mica-slates, with quartzose sandstone; (2) crystalline limestone; (3) argillaceous slates, with hard sandstones, conglomerates, and thin beds and strings of calcareous matter; (4) compact limestone, forming the Laventille hills bordering the plain of Caroni. The total thickness of these rocks in Trinidad is stated by the author at upwards of 10,000 feet; and he is of opinion that the thickness of the whole group is many times greater than this, a portion of the series in Venezuela being probably inferior in position to the rocks exposed in Trinidad. A high angle of inclination almost everywhere prevails, the general range of dip being from 30° to the vertical. After noticing the difficulty which has hitherto existed in determining the age of the Caribbean formation, from the want of fossil evidence, the author stated that he found undoubted traces of the existence of organisms during the depositions of these rocks. In the uppermost compact dark-blue limestone (No. 4) obscure fossils occur. In the clay-slate and quartz rocks (No. 3) underlying this limestone there are strings and bands of calcareous matter which sometimes contain fossils. In a portion of one of these strings, found by the author about 3 feet below the surface in the decomposed mica-slate forming the soil of one of the valleys, he detected a structure which he regards as of animal origin, and as probably most nearly related to *Eozoon.* He was unable to detect any traces of tubulation in it, but suggests that this character may have been obliterated, as in the Tudor specimen ("Quart. Journ. Geol. Soc." vol. xxiii., p. 257). The chambers are said by the author to be more elliptical than those of *Eozoon canadense;* and for this and other reasons he proposed to regard it as a new species, under the name of *Eozoon*

caribbæum. Associated with this supposed *Eozoon*, the author has found other remains. These include fragments of coral, some of which are stated to resemble *Favosites*, although no pores or tabulæ could be detected in them. These fragments are thought by the author to have belonged to a minute branching *Favosites*, which he proposes to name *F. fenestralis*. Plates and stems of Echinoderms are scattered through the rock. The author particularly described a specimen consisting of 5 ambulacral plates, with 4 pairs of pores, and another fragment showing portions of at least 20 ambulacral or pseudo-ambulacral plates, reminding one of those of the Devonian *Eleacrinus*. The author has found that the bands of calcareous matter interstratified among the slates are seldom devoid of organic remains, except when they are very highly metamorphic. In a finely laminated limestone he found great abundance of obscure fossils, many of which appeared to be remains of Crystidea, whilst others resemble annelid-tubes, like *Salterella*. The author suggested that the function of *Eozoon* in pre-Cambrian times was anologous to that of corals at subsequent periods. He considered that there is the highest probability that the Caribbean series will ultimately prove to be pre-Silurian.

In the discussion which followed the reading of this paper, Dr. Carpenter, from the slight examination he had been able to make of the fossils, was unwilling to speak decidedly about them. There was, however, no doubt of numerous organic remains occurring in the rocks, and among them serpuline shells and echinoderms. As to the supposed *Eozoon*, he had not been able to recognize any of the characteristics of that fossil; and by treating the Trinidad specimens with acid he found no traces of structure left, and yet there had not been sufficient metamorphism to destroy other organisms. In some dredgings from the Ægean Sea he had found fragments of echinoderms and other organisms, in which a siliceous deposit had replaced the original sarcode in the same manner as had occurred in the Canadian *Eozoon*, thus proving the possibility of this form of constitution, which had been warmly contested. — *Quar. Jour. Geol. Soc.*, XXVI. (1870), *pp.* 413–414.

GEOLOGICAL BREVITIES.

Evidences of Recent Changes of Level on the Mediterranean Coast. – Mr. G. Maw presented a paper with the above title at the Liverpool meeting of the British Association. He described the structure of the coast, the general absence of the sea-cliffs within the Straits of Gibraltar, due to the shelving contour of the land under the sea. He considered the inset current from the Atlantic as indicating a general subsidence of the whole Mediterranean basin; Sir Charles Lyell, however, considered that the outward current balanced the inward current, and that therefore this evidence of submergence was of no weight. Mr. Maw alluded to the submarine springs passing through channels of subaerial *origin occurring* in the coast caverns, and considered this fact a proof of the submergence of the coast line. Evidences of upheaval are to be found in the lagoons and flats which abound on the coast of Corsica, and which are covered with long ridges of shingle deposited by streams which debouched on the marsh before it was submerged. There is, moreover, at Gibraltar a great deposit of stratified sand at Catalan Bay, which would seem to show a submergence of 700 feet; and at Cadiz, as well as at Tangiers on the other side of the basin, raised sea-beaches are to be found. Professor Bush gave his own observations on the rock terraces and caverns of the rock of Gibraltar. There are three successive terraces exhibited on the eastern side of the rock, only showing that a barrier extended in recent geological times across the straits, the Mediterranean being then confined to a higher level than the Atlantic. The changes described by Mr. Maw he regarded as the last of a series indicated by the terraces at Gibraltar.

Modern Instances of Elevation.—In a letter to Elie de Beaumont, M. de Botella says: " From the village of Villar don Diego, in the province of Zamora, it is now possible to see half the bell-tower of the Benifarzes, a village in the province of Valladolid, while 23 years ago (1847) it was scarcely possible to see the top of the same tower.

" A similar fact has been noticed in the province of Alava, it now being possible to perceive from the village of Salvatierra the whole village of Salduente, while in 1847 it was difficult to distinguish the vane of its bell-tower. The four points mentioned are on a line passing through Burgos, and having a direction W. 28° 39′ S., that is, nearly parallel to the system of the Sancerrois. The extremities of this line are 300 kilom. apart. — *Comptes Rendus, May*, 1870, *p*. 1141.

Lignite from Vescovado, Province of Sienna, Italy.—M. Kopp.—At only 8 metres under the surface of the soil is found a layer of lignite of 3.5 metres thickness. This substance, having been submitted to analysis, yielded, on being dried at 115°, 21.80 per cent. of water. On being calcined in a closed crucible, 100 parts gave volatile combustible matter, 26.48; fixed carbon, 42.52; ash, 9.20; water, 21.80. When submitted to dry distillation in a gas retort, acetic acid is among the products, and 51 per cent. of coke; the quantity of sulphur amounts to 1.36 per cent. One kilo. of lignite is capable, on combustion, of evaporating 6.1 litres of water. Since there is no coal found in any part of Italy, as far at least as it has been explored, this material is of considerable value to the industry of that country.—*Moniteur Scientifique.*

Age of the Wealden. — *Mr. E. W. Judd.* — The Wealden constitutes one great continuous formation with well-defined paleontological characters. As with the "Poikilitic" series, its beds can only be referred to the different members of our established marine classification by violent and arbitrary divisions. It must therefore stand as one of the terms of that new system of terrestrial classification which Professor Huxley has shown must be founded. The epoch of the English Wealden commenced towards the close of the Oölitic period; it continued during the whole of the Tithonian, and ceased towards the end of the Middle or beginning of the Upper Neocomian. The passage of the Upper Oölite into the Wealden and that of the Wealden into the Upper Neocomian were gradual. Fresh-water deposits were formed continuously, but not contemporaneously, over the whole area of the Wealden, so that in the north-west we find only the lower beds represented and in the south-east only the upper ones, while in the central portion we find the whole series complete. In the little marine band of Punfield, only 21 inches high, we have the representative of a portion of the middle Neocomian, a formation found elsewhere in England only in the middle of the Speeton clay and in Lincolnshire. The fauna of the marine band of Punfield has very striking affinities with that of the coal-bearing strata of eastern Spain (which are more than 1,600 feet thick), and especially with the middle portion of that series. The North German Wealden, which is quite unconnected with that of England, is not strictly contemporaneous with the latter, for while it appears to have commenced at about the same period, its duration was considerably less, it having terminated the close of the Lower Neocomian. — *British Association, Liverpool Meeting.*

British Fossil Corals. — Professor P. M. Duncan, in a Report on British Fossil Corals, says that the distinction between the palæozoic and the later coral faunæ is not proved to be as exact as has been supposed, and that the aporose and perforate corals exist in the palæozoic rocks as well as the rugose and tabulate forms, which latter have closely allied living analogues.

Kent's Cavern.— The Kent's Cavern Exploration Committee of the British Association reported at the Liverpool meeting that they had, during the past year, explored the only remaining unexplored portions of the eastern division of the cave. The south *Sally Port* (so-called) has a south-east direction into the hill and away from the hill-side; it occupies a space of 80 by 40 feet. It was filled, first, with a red cave-earth from 12 to 20 inches thick; second, with a stalagmitic floor from 1 to 24 inches thick; third, with a cave earth of unknown depth, but exceeding 5 feet. The excavations yielded a large number of bones (including those of several birds and a few fishes), portions of antlers and teeth, more or less perfect, in some cases attached to the jawbone; there were also found wings and elitra of beetles. The teeth found belonged to the horse, hyena, rhinoceros, bear, sheep, badger, fox, rabbit, elephant, deer, lion, ox, hare, and pig. A number of flint implements were also discovered. The north Sally Port is somewhat larger, covering an area of 84 by 86 feet, and opens in the eastern slope of the hill. The disposition of the floor-layers and of the animal remains is similar to that in the south Sally Port.

Gold in Scotland. — Dr. Bryce has found that the matrix of the gold in the Scottish gold fields is a granite which, being crushed, gives evidence of the presence of gold, although the amount is too small to make its extraction profitable.

Platinum in Lapland. — In a letter dated Stockholm, May 11, 1870, Professor Nordenskiöld announces the finding of platinum among the gold collected the last summer in considerable quantities, and sometimes in quite large pieces, in the sands of the Ivalo River, in Northern Lapland. — *Poggendorf's Annalen, No.* 6, 1870.

Silver Ore in India.— Argentiferous galena has been discovered in the district of Beerbhoom, in India, by Mr. Ball, of the Geological Survey. The assay of some picked specimens gives 110 oz. silver to the ton of lead, and it is considered that there is a sufficient quantity of ore to justify working. — *Nature.*

Australian Corals. — The most interesting of the corals from the Cainozoic deposits of South Australia are the Conosmiliæ. It is a genus perfectly Australian in its abnormalities. A simple coral with a pellicular epitheca, having a beautiful herring-bone ornamentation, with an essential, twisted, *sérialaire* columella with endothecal dissepiments and with plain septa, which have the hexameral arrangement in some, and the octomeral in others, is a form containing the elements of several classificatory series. The irregular septal arrangement amongst the closely allied species may be considered to depend upon atavism. Such octomeral cyclical arrangements occurred in some genera in the lower greensand period and during the oölites. Some of the liassic *Montlivaltiæ* clearly reflected this rugose peculiarity, and *M. Ruperti* (Duncan) had a quaternary cyclical arrangement.

It is remarkable that the septo-costal peculiarity, already mentioned as occurring in the Australian *Flabellum Victoriæ* and in the two species of *Sphenotrochus*, should be noticed in all the species of *Conosmilia*. The continuation of the septa and costæ is likewise wanting in some liassic *Montlivaltiæ* and in many simple *Rugosa*. The importance of the Conosmiliæ can hardly be estimated at present; but it is evident that they are very synthetic forms, occurring late in the coral faunas of the world. The genus *Haplophyllia* (Pourtales), whose solitary species were dredged in 324 fathoms off the Florida reef, has a styliform columella and an octomeral arrangement of the septa. There are no endothecal dissepiments. — *Quar. Jour. Geol. Soc.*

An Existing Coral allied to a Palæozoic Type. — Mr. W. S. Kent, in the "Annals and Magazine of Natural History," describes a specimen of coral of undoubted recent character, although of unknown locality. From its generic resemblance to the extinct genus *Favosites* he has named it *Favositipora Deshayesii.* Mr. Kent has found in the British Museum a specimen of fossil coral belonging to the same genus, and most probably of North American Devonian or Carboniferous origin. This second species is named *F. palæozoica.* "Not only is the existing *F. Deshayesii* interesting on account of its close relationship to extinct palæozoic forms, but its affinity to the recent genus *Alveopora*, from which it differs only by its possession of scattered tabulæ, is weighty evidence in controversion of the theory advocated by Professor Agassiz, that all the tabulate corals are the skeletal productions of Hydrozoa. Alveopora is a well-known Actinozoön, and it is more than probable that the closely approximating *Favositipora* is referable to the same class."

Fossils of Nevada. — F. B. Meek, in a letter in the Proceedings of the Academy of Natural Sciences, Philadelphia, which accompanies the description of a few of the fossils collected by Clerence King, Esq., of the U. S. Geological Survey says: —

"The trilobites described from Eastern Nevada are decidedly primordial types, and, so far as I know, the first fossils of that age yet brought in from any locality west of the Black Hills. Mr. King's collections also establish the fact that the rich silver mines of the White Pine districts occur in Devonian rocks, though the Carboniferous is also well developed there. The Devonian beds of that district yet known by their fossils seem mainly to belong to the upper part of that system. Mr. King, however, has a few fossils from Pinon Station, Central Nevada, that appear to belong to the horizon of the Upper Helderberg limestone of the New York series.

"The tertiary fossils from the region of Hot Spring Mountains, Idaho, came from an extensive and interesting fresh-water lacustrine deposit, and are all distinct specifically, and some generically, from all the other tertiary fossils yet brought from the Far West. Two of the species belong to the existing California genus Carinifex, or some closely allied group, while another beautifully sculptured species may possibly be a true *Melania*, and allied to existing Asiatic forms.

"It is an interesting fact that among all four fresh-water tertiary shells from this distant internal part of the continent, neither the beaks of the bivalves nor the apices of the spores of the univalves are ever in the slightest degree eroded; even the most delicate markings on these parts being perfectly preserved, if not broken by some accident. From this fact it may be inferred that the waters of the lakes and streams of this region during the tertiary epoch were more or less alkaline, as is the case with many of those there at the present day."

A Fossil Tooth from Table Mountain; by Professor W. P. Blake. — The fossil tooth found by Mr. D. T. Hughes, 1,700 ft. under Table Mountain and 300 ft. below the surface, I have carefully examined and compared with specimens in the Smithsonian Institution. It proves to be a back lower molar of an equine animal of the genus *Hipparion*, or a closely allied genus. This genus is one of the connecting links between the *Palæotherium* and the horse.

The specimen closely resembles a fossil in the Smithsonian Museum from the pliocene formations of the Niobrara River in Nebraska, not only in size, but in the foldings of the enamel, and particularly in the posterior part of the tooth, but it differs enough in several particulars to justify the belief that it is a distinct species. This fossil is the first of the kind discovered west of the Rocky Mountains. It adds to the list of the fauna antedating Table Mountain, — a list which includes the mammoth, the rhinoceros, and an animal allied to the elk. I have believed that remains of man were also found under the lava; but upon this point, after diligent inquiry, I am satisfied that the evidence is insufficient. But we now add this fossil allied to *Hipparion*, and I regard it as another indication that the Table Mountain beds are pliocene and homotaxial with those of the Bad Lands of Nebraska. — *Amer. Jour. Science*, 1870, L., *page* 262.

Alkaline Lakes of California. — It appears that a portion of California is very rich in mineral waters, and, moreover, contains large sheets of water, evidently occupying the craters of extinct volcanoes. The water of Lake Owen has a specific gravity of 1.076 and contains 7,128.24 grains of solid matter to the gallon, consisting of 2,942 grains of chloride of sodium, 956 grains of sulphate of sodium, 2,914 grains of carbonate of sodium, together with sulphate and phosphate of potassium, silica, and a small amount of organic matter. The Kaysa, or borax lake, yields daily 3,000 pounds of crude borax composed in 100 parts of, dry biborate of sodium, 51.85; water of crystallization, 45.44; dry sulphate of sodium, 0.06; chloride of sodium, 0.08; phosphate of sodium, 1.15; insoluble matter, 1.42. The water of this lake has a sp. gr. of 1.0274, and contains in a gallon, chloride of sodium, 1,198.66 grains; chloride of potassium, 9.92 grains; iodine of magnesium, 0.22 grains; bromide of magnesium, trace; carbonate of sodium, 578.65 grains; biborate of sodium, 281.48 grains; phosphate of aluminum, 3.52 grains; sulphate of calcium, trace; silica, 2.37 grains; volatile and organic matters, 238.66. The mud of this lake contains large quantities of crystallized borax; at some short distance from this lake a rich sulphur deposit is met with which contains a vein of cinnabar; both of these minerals are now worked. The quantity of sulphur daily obtained amounts to some 7 tons. — *Bull. de la Soc. d'Encour.*

Submergence of a large Portion of the North American Continent. — Prof. C. H. Hitchcock, of the New Hampshire State Geological Survey, finds an argument for the submergence of a large portion of the North American continent since the drift period in the existence of 27 species of maritime plants in the interior along the great lakes. These extend up the Hudson River and Champlain Valley and along the Lakes of Ontario and Erie to Minnesota. He argues that these plants were originally introduced by natural emigration along an ancient estuary, and that many of them remain to the present day in consequence of the existence of conditions favorable to their preservation. He supposes that the plants about the salt springs in Northern New York were introduced in the same way. The pre-glacial flora has been completely destroyed by the intense cold, and while a new creation might explain the existence of salt-water plants about the springs, it would not show why these marine plants could exist in the far interior. There should be a special fitness of species to conditions, in case the creation theory is invoked. He concludes that the continent must have been submerged 200 or 300 feet lower than geologists have supposed, relying upon the ordinary arguments, and that the clays about Superior and Erie must have been of marine or estuary origin.

Asbestus and Corundum at Pelham, Mass. — In the towns of Pelham and Shutesbury, Mass., there are several localities of asbestus known to mineralogists, indifferent specimens from which place are common in collections. Recent excavations to obtain asbestus for economical purposes reveal its presence in great quantity. Much of it is soft, of a grayish-white color, composed of delicate parallel fibres often a foot in length, with a marked cross cleavage oblique to the fibres, as in hornblende.

Intimately associated with the asbestus is an altered mica allied to vermiculite or jefferisite. It differs, however, in certain physical characters from the jefferisite of Westchester, Pa., but seems to resemble it in its optical characters. There also occurs, at the same locality, a white corundum, sometimes streaked with blue, and occurring in nodules of corundophillite. It occurs in small quantity, but farther excavations promise to afford it in greater abundance.—*Amer. Jour. Science, March*, 1870.

Native Iron and Lead.—At a meeting of the American Philosophical Society, Dr. Genth showed specimens of native iron and native lead from the bed-rock of gold-placers covered with about 6 feet of gravel, at Camp Creek, Montana Territory. The native iron is found in small angular fragments, but slightly coated with rust; the largest which he has seen is about 0.5 inch in length. Etching with dilute nitric acid does not develop any Widmannstædtean figures, but a finely granular structure. The lead was examined for nickel and cobalt with negative results. Associated with the iron is native lead, in irregularly shaped rounded and flattened pieces from the size of a pin's head to about 0.5 inch in diameter. The lead is coated with a crystalline coat of *massicot*, of a sulphur-yellow to reddish-yellow color; some pieces also show very brilliant but microscopic crystals, which may be *cerussite*. Acetic acid dissolves this massicot, and leaves the metallic lead, which then shows its crystalline structure. The lead showed traces of gold, but no silver.

BIOLOGY.

PROFESSOR HUXLEY'S ADDRESS.

At the meeting of the British Association, Professor Huxley, after presenting a long series of facts bearing upon the germ theory, continued: —

"To sum up the effect of this long chain of evidence, it is demonstrable that a fluid eminently fit for the development of the lowest forms of life, but which contains neither germs nor any protean compound, gives rise to living things in great abundance, if it is exposed to ordinary air; while no such development takes place if the air with which it is in contact is mechanically freed from the solid particles which ordinarily float in it, and which may be made visible by appropriate means. It is demonstrable that the great majority of these particles are destructible by heat, and that some of them are germs, or living particles, capable of giving rise to the same forms of life as those which appear when the fluid is exposed to unpurified air. It is demonstrable that inoculation of the experimental fluid with a drop of liquid known to contain living particles gives rise to the same phenomena as exposure to unpurified air. And it is further certain that these living particles are so minute that the assumption of their suspension in ordinary air presents not the slightest difficulty. On the contrary, considering their lightness and the wide diffusion of the organisms which produce them, it is impossible to conceive that they should not be suspended in the atmosphere in myriads. Thus, the evidence, direct and indirect, in favor of biogenesis for all known forms of life, must, I think, be admitted to be of great weight. On the other side, the sole assertions worthy of attention are, that hermetically sealed fluids, which have been exposed to great and long-continued heat, have sometimes exhibited living forms of low organization when they have been opened. The first reply that suggests itself is the probability that there must be some error about these experiments, because they are performed on an enormous scale every day, with quite contrary results. Meat, fruit, vegetables, the very materials of the most fermentable and putrescible infusions, are preserved to the extent, I suppose I may say, of thousands of tons every year, by a method which is a mere application of Spellanzani's experiment. The matters to be preserved are well boiled in a tin case provided with a small hole, and this hole is soldered up when all the air in the case has been replaced by steam. By this method they may be kept for years, without putrefying, fermenting, or getting mouldy. Now this is not because oxygen is excluded, inasmuch as it is now proved that free oxygen is not necessary for either fermentation or putrefaction. It is not because the tins are exhausted of air, for *Vibriones* and *Bacteria* live, as Pasteur has shown, without air or free oxygen. It is not because the boiled meat or vegetables are not putrescible or fermentable, as those who have had the misfortune to be in a ship supplied with unskilfully closed tins well know. What is it, therefore, but the exclusion of germs? I think that abiogenists are bound to answer this question before they ask us to consider new experiments of precisely the same order. And in the next place, if the results of the experiments I refer to are really trustworthy, it by no means follows that abiogenesis has taken place. The resistance of living matter to heat is known to vary within considerable limits, and to depend, to some extent, upon the chemical and physical qualities of the surrounding medium. But if, in the present state of science, the alternative is offered us, either germs can stand a greater heat than has been supposed, or the molecules of dead matter, for no valid or intelligible reason that is assigned, are able to rearrange themselves into living bodies, exactly such as can be demonstrated to be frequently produced in another way, I cannot understand how choice can be, even for a moment, doubtful. But though I cannot express this conviction of mine too strongly, I must carefully guard myself against the supposition that I intend to suggest that no such thing as abiogenesis ever has taken place in the past, or ever will take place in the future. With organic chemistry, molecular physics, and physiology yet in their infancy, and every day making prodigious strides, I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call 'vital' may not, some day, be artificially brought together. All I feel justified in affirming is, that I see no reason for believing that the feat has been performed yet. And, looking back through the prodigious vista of the past, I find no record of the commencement of life, and therefore I am devoid of any means of forming a definite conclusion as to the conditions of its appearance. Belief, in the scientific sense of the word, is a serious matter, and needs strong foundations. To say, therefore, in the admitted absence of evidence, that I have any belief as to the mode in which the existing forms of life have originated, would be using words in a wrong sense. But expectation is permissible where belief is not; and if it were given me to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions, which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not living matter. I should expect to see it appear under forms of great simplicity, endowed, like existing *fungi*, with the power of determining the formation of new protoplasm from such matters as ammonium carbonates, oxalates and tartrates, alkaline and earthy phosphates, and water, without the aid of light. That is the expectation to which analogical reasoning leads me; but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith. So much for the history of the progress of Redi's great doctrine of biogenesis, which appears to me, with the limitations I have expressed, to be victorious along the whole line at the present day. As regards the second problem offered to us by Redi, whether xenogenesis obtains, side by side with homogenesis; whether, that is, there exist not only the ordinary living things, giving rise to offspring which run through the same cycle as themselves, but also others, producing offspring which are of a totally different character from themselves, the researches of two centuries have led to a different result. That the grubs found in galls are no product of the plants on which the galls grow, but are the result of the introduction of the eggs of insects into the substance of these plants, was made out by Vallisnieri, Reaumer, and others, before the end of the first half of the eighteenth century. The tape-worms, bladder-worms, and flukes continued to be a stronghold of the advocates of xenogenesis for a much longer period. Indeed, it is only within the last thirty years that the splendid patience of Von Siebold, Van Beneden, Leuckart, Küchenmeister, and other helminthologists, has succeeded in tracing every such parasite, often through the strangest wanderings and metamorphoses, to an egg derived from a parent, actually or potentially like itself; and the tendency of inquiries elsewhere has all been in the same direction. A plant may throw off bulbs, but these, sooner or later, give rise to seeds or spores, which develop into the original form. A polype may give rise to medusæ, or a pluteus to an echinoderm, but the medusa and the echinoderm give rise to eggs which produce polypes or plutei, and they are therefore only stages in the cycle of life of the species. But if we turn to pathology it offers us some remarkable approximations to true xenogenesis. As I have already mentioned, it has been known since the time of Vallisnieri and of Reaumur, that galls in plants, and tumors in cattle, are caused by insects, which lay their eggs in those parts of the animal or vegetable frame of which these morbid structures are outgrowths. Again, it is a matter of familiar experience to everybody that mere pressure on the skin will give rise to a corn. Now the gall, the tumor, and the corn are parts of the living body, which have become, to a certain degree, independent and distinct organisms. Under the influence of certain external conditions, elements of the body, which should have developed in due subordination to its general plan, set up for themselves and apply the nourishment which they receive to their own purposes. From such innocent productions as corns and warts, there are all gradations, to the serious tumors which, by their mere size and the mechanical obstruction they cause, destroy the organism out of which they are developed; while, finally, in those terrible structures known as cancers, the abnormal growth has acquired powers of reproduction and multiplication, and is only morphologically distinguishable from the parasitic worm, the life of which is neither more nor less closely bound up with that of the infested organism. If there were a kind of diseased structure, the histological elements of which were capable of maintaining a separate and independent existence out of the body, it seems to me that the shadowy boundary between morbid growth and xenogenesis would be effaced. And I am inclined to think that the progress of discovery has almost brought us to this point already. I have been favored by Mr. Simon with an early copy of the last published of the valuable 'Reports on the Public Health,' which, in his capacity of their medical officer, he annually presents to the Lords of the Privy Council. The appendix to this report contains an introductory essay 'On the Intimate Pathology of Contagion,' by Dr. Burdon Sanderson, which is one of the clearest, most comprehensive, and well-reasoned discussions of a great question which has come under my notice for a long time. I refer you to it for details and for the authorities for the statements I am about to make. You are familiar with what happens in vaccination. A minute cut is made in the skin, and an infinitesimal quantity of vaccine matter is inserted into the wound. Within a certain time, a vesicle appears in the place of the wound, and the fluid which distends this vesicle is vaccine matter, in quantity a hundred or a thousand fold that which was originally inserted. Now what has taken place in the course of this operation? Has the vaccine matter by its irritative property produced a mere blister, the fluid of which has the same irritative property? Or does the vaccine matter contain living particles, which have grown and multiplied where they have been planted? The observations of M. Chauveau, extended and confirmed by Dr. Sanderson himself, appear to leave no doubt upon this head. Experiments, similar in principle to those of Helmholtz, on fermentation and putrefaction, have proved that the active element in the vaccine lymph is non-diffusible, and consists of minute particles not exceeding one-twenty-thousandth of an inch in diameter, which are made visible in the lymph by the microscope. Similar experiments have proved that two of the most destructive of epizoötic diseases, sheep pox and glanders, are also dependent for their existence and their propagation upon extremely small living solid particles, to which the title of 'microzymes' is applied. An animal suffering under either of these terrible diseases is a source of infection and contagion to others, for precisely the same reason as a tub of fermenting beer is capable of propagating its fermentation, by 'infection' or 'contagion,' to fresh wort. In both cases it is the solid living particles which are efficient; the liquid in which they float, and at the expense of which they live, being altogether passive. Now arises the question, Are these microzymes the results of homogenesis, or of xenogenesis; are they capable, like the *Torulæ* of yeast, of arising only by the development of pre-existing germs; or may they be, like the constituents of a nutgall, the results of a modification and individualization of the tissues of the body in which they are found, resulting from the operation of certain conditions? Are they parasites in the zoölogical sense, or are they merely what Virchow has called 'heterologous growths'? It is obvious that this question has the most profound importance, whether we look at it from a practical or from a theoretical point of view. A parasite may be stamped out by destroying its germs, but a pathological product can only be annihilated by removing the conditions which give rise to it. It appears to me that this great problem will have to be solved for each zymotic disease separately, for analogy cuts two ways. I have dwelt upon the analogy of pathological modification, which is in favor of the xenogenetic origin of microzymes; but I must now speak of the equally strong analogies in favor of the origin of such pestiferous particles by the ordinary process of the generation of like from like. It is, at present, a well-established fact, that certain diseases, both of plants and of animals, which have all the characters of contagious and infectious epidemics, are caused by minute organisms. The smut of wheat is a well-known instance of such a disease, and it cannot be doubted that the grape disease and the potato disease fall under the same category. Among animals, insects are wonderfully liable to the ravages of contagious and infectious diseases caused by microscopic *fungi*. In autumn, it is not uncommon to see flies, motionless upon a window-pane, with a sort of magic circle, in white, drawn round them. On microscopic examination, the magic circle is found to consist of innumerable spores, which have been thrown off in all directions by a minute fungus called *Empusa muscæ*, the spore-forming filaments of which stand out like a pile of velvet from the body of the fly. These spore-forming filaments are connected with others, which fill the interior of the fly's body like so much fine wool, having eaten away and destroyed the creature's viscera. This is the full-grown condition of the *Empusa*. If traced back to its earlier stages, in flies which are still active, and to all appearance healthy, it is found to exist in the form of minute corpuscles which float in the blood of the fly. These multiply and lengthen into filaments, at the expense of the fly's substance; and when they have at last killed the patient, they grow out of its body and give off spores. Healthy flies shut up with diseased ones catch this mortal disease and perish like the others. A most competent observer, M. Cohn, who studied the development of the *Empusa* in the fly very carefully, was utterly unable to discover in what manner the smallest germs of the *Empusa* got into the fly. The spores could not be made to give rise to such germs by cultivation, nor were such germs discoverable in the air, or in the food of the fly. It looked exceedingly like a case of abiogenesis, or, at any rate, of xenogenesis; and it is only quite recently that the real course of events has been made out. It has been ascertained that when one of the spores falls upon the body of a fly, it begins to germinate and sends out a process which bores its way through the fly's skin; this, having reached the interior cavities of its body, gives off the minute floating corpuscles which are the earliest stage of the *Empusa*. The disease is 'contagious,' because a healthy fly coming in contact with a diseased one, from which the spore-bearing filaments protrude, is pretty sure to carry off a spore or two. It is 'infectious,' because the spores become scattered about all sorts of matter in the neighborhood of the slain flies.

"The silkworm has long been known to be subject to a very fatal and contagious and infectious disease called the *Muscardine.* Audouin transmitted it by inoculation. This disease is entirely due to the development of a fungus, *Botrytis Bassiana,* in the body of the caterpillar; and its contagiousness and infectiousness are accounted for in the same way as those of the fly-disease. But of late years a still more serious epizootic has appeared among the silkworms; and I may mention a few facts which will give you some conception of the gravity of the injury which it has inflicted on France alone. The production of silk has been for centuries an important branch of industry in Southern France, and in the year 1853 it had attained such a magnitude, that the annual produce of the French sericulture was estimated to amount to a tenth of that of the whole world, and represented a money value of 117,000,000 of francs, or nearly 5,000,000 sterling. What may be the sum which would represent the money value of all the industries connected with the working up of the raw silk thus produced is more than I can pretend to estimate. Suffice it to say, that the city of Lyons is built upon French silk, as much as Manchester was upon American cotton, before the civil war. Silkworms are liable to many diseases; and, even before 1853, a peculiar epizootic, frequently accompanied by the appearance of dark spots upon the skin (whence the name of 'Pébrine' which it has received), had been noted for its mortality. But in the years following 1853, this malady broke out with such extreme violence, that in 1856 the silk crop was reduced to a third of the amount which it had reached in 1853; and, up till within the last year or two, it has never attained half the yield of 1853. This means not only that the great number of people engaged in silk-growing are some 30,000,000 sterling poorer than they might have been; it means not only that high prices have had to be paid for imported silkworm eggs, and that, after investing his money in them, in paying for mulberry-leaves and for attendance, the cultivator has constantly seen his silkworms perish and himself plunged in ruin, but it means that the looms of Lyons have lacked employment, and that, for years, enforced idleness and misery have been the portion of a vast population, which, in former days, was industrious and well-to-do. In 1858, the gravity of the situation caused the French Academy of Sciences to appoint commissioners, of whom a distinguished naturalist, M. de Quatrefages, was one, to inquire into the nature of this disease, and, if possible, to devise some means of staying the plague. In reading the report made by M. de Quatrefages in 1858, it is exceedingly interesting to observe that his elaborate study of the Pébrine forced the conviction upon his mind that, in its mode of occurrence and propagation, the disease of the silkworm is, in every respect, comparable to the cholera among mankind. But it differs from the cholera, and, so far, is a more formidable disease, in being hereditary, and in being, under some circumstances, contagious, as well as infectious. The Italian naturalist, Filippi, discovered in the blood of the silkworms affected by this strange disease, a multitude of cylindrical corpuscles, each about one six-thousandth of an inch long. These have been carefully studied by Lebert, and named by him *Panhistophyton;* for the reason that, in subjects in which the disease is strongly developed, the corpuscles swarm in every tissue and organ of the body, and even pass into the undeveloped eggs of the female moth. But are these corpuscles causes, or mere concomitants, of the disease? Some naturalists took one view and some another; and it was not until the French government, alarmed by the continued ravages of the malady, and the inefficiency of the remedies which had been suggested, dispatched M. Pasteur to study it, that the question received its final settlement, at a great sacrifice, not only of the time and peace of mind of that eminent philosopher, but, I regret to have to add, of his health. But the sacrifice has not been in vain. It is now certain that this devastating, cholera-like Pébrine is the effect of the growth and multiplication of the *Panhistophyton* in the silkworm. It is contagious and infectious, because the corpuscles of the *Panhistophyton* pass away from the bodies of the diseased caterpillars, directly or indirectly, to the alimentary canal of healthy silkworms in their neighborhood; it is hereditary, because the corpuscles enter into the eggs while they are being formed, and consequently are carried within them when they are laid; and for this reason, also, it presents the very singular peculiarity of being inherited only on the mother's side. There is not a single one of all the apparently capricious and unaccountable phenomena presented by the Pébrine, but has received its explanation from the fact that the disease is the result of the presence of the microscopic organism *Panhistophyton.*

"Such being the facts with respect to the Pébrine, what are the indications as to the method of preventing it? It is obvious that this depends upon the way in which the *Panhistophyton* is generated. If it may be generated by abiogenesis, or by xenogenesis, within the silkworm or its moth, the extirpation of the disease must depend upon the prevention of the occurrence of the conditions under which this generation takes place. But if, on the other hand, the *Panhistophyton* is an independent organism, which is no more generated by the silkworm than the mistletoe is generated by the oak or the apple-tree on which it grows, though it may need the silkworm for its development in the same way as the mistletoe needs the tree, then the indications are totally different. The sole thing to be done is to get rid of and keep away the germs of the *Panhistophyton.* As might be imagined, from the course of his previous investigations, M. Pasteur was led to believe that the latter was the right theory; and guided by that theory, he has devised a method of extirpating the disease, which has proved to be completely successful wherever it has been properly carried out. There can be no reason, then, for doubting that, among insects, contagious and infectious diseases, of great malignity, are caused by minute organisms which are produced from pre-existing germs, or by homogenesis; and there is no reason that I know of for believing that what happens in insects may not take place in the highest animals. Indeed, there is already strong evidence that some diseases of an extremely malignant and fatal character, to which man is subject, are as much the work of minute organisms as in the Pébrine. I refer for this evidence to the very striking facts adduced by Professor Lister in his various well-known publications on the antiseptic method of treatment. It seems to me impossible to rise from the perusal of those publications without a strong conviction that the lamentable mortality which so frequently dogs the footsteps of the most skilful operator, and those deadly consequences of wounds and injuries which seem to haunt the very walls of great hospitals, and are, even now, destroying more men than die of bullet or bayonet, are due to the importation of minute organisms into wounds, and their increase and multiplication; and that the surgeon who saves most lives will be he who best works out the practical consequences of the hypothesis of Redi.

"I commenced this address by asking you to follow me in an attempt to trace the path which has been followed by a scientific idea, in its long and slow progress from the position of a probable hypothesis to that of an established law of nature. Our survey has not taken us into very attractive regions; it has lain chiefly in a land flowing with the abominable, and peopled with mere grubs and mouldiness. And it may be imagined with what smiles and shrugs, practical and serious contemporaries of Redi and of Spallanzani may have commented on the waste of their high abilities in toiling at the solution of problems which, though curious enough in themselves, could be of no conceivable utility to mankind. Nevertheless, you will have observed, that before we had travelled very far upon our road, there appeared, on the right and on the left, fields laden with a harvest of golden grain, immediately convertible into those things which the most sordidly practical of men will admit to have the value, namely, money and life. The direct loss to France caused by the Pébrine in 17 years cannot be estimated at less than 50,000,000 sterling; and if we add to this what Redi's idea, in Pasteur's hands, has done for the wine-grower and for the vinegar-maker, and try to capitalize its value, we shall find that it will go a long way towards repairing the money losses caused by the frightful and calamitous war of this autumn. And as to the equivalent of Redi's thought in life, how can we overestimate the value of that knowledge of the nature of epidemic and epizoötic diseases, and consequently of the means of checking or eradicating them, the dawn of which has assuredly commenced? Looking back no further than 10 years, it is possible to select 3 (1863, 1864, and 1869) in which the total number of deaths, from scarlet fever alone, amounted to 90,000. That is the return of killed, the maimed and disabled being left out of sight. Why, it is to be hoped that the list of killed in the present bloodiest of all wars will not amount to more than this! But the facts, which I have placed before you, must leave the least sanguine without a doubt that the nature and the causes of this scourge will, one day, be as well understood as those of the Pébrine are now, and that the long-suffered massacre of our innocents will come to an end. And thus mankind will have one more admonition that 'the people perish for lack of knowledge;' and that the alleviation of the miseries and the promotion of the welfare of men must be sought, by those who will not lose their pains, in that diligent, patient, loving study of all the multitudinous aspects of nature, the results of which constitute exact knowledge or science. It is the justification and the glory of this great meeting that it is gathered together for no other object than the advancement of the moiety of science which deals with those phenomena of nature which we call physical. May its endeavors be crowned with a full measure of success!"

MR. BENTHAM'S ADDRESS.

Mr. Bentham's Presidential Address at the anniversary meeting this year is devoted mainly to two topics: (1) The results obtained from recent explorations of the deep-sea faunas; (2) those from the investigation of the tertiary deposits of the Arctic regions, "tending both of them to elucidate in a remarkable degree one of the most important among the disputed questions in biological history, the continuity of life through successive geological periods."

Mr. Bentham, after disclaiming any effort to trace the outlines of the revolution caused by these discoveries in previous theories, both as to the geographical distribution of marine animals, or to the influences of temperature and depth upon this distribution, says: "My object is more especially to point out how these respective dips into the early history of marine animals and of terrestrial forests have afforded the strongest evidence we have yet obtained, that apparently unlimited permanency and total change can go on side by side, without requiring for the latter any general catastrophe that should preclude the former.

"There was a time, as we learn, when our chalk cliffs, now high and dry, were being formed at the bottom of the sea by the gradual growth and decay of Globigerinæ and the animals that fed on them, — amongst others, for instance, Rhizocrinus and Terebratulina caput-serpentis; and when, at a later period, the upheaval of the ground into an element where these animals could no longer live arrested their progress in that direction, they had already spread over an area sufficiently extensive for some part of their race to maintain itself undisturbed; and so on, from that time to the present day, by gradual dispersion or migration, in one direction or another, the same Rhizocrinus and Terebratulina have always been in possession of some genial locality, where they have continued from generation to generation, and still continue, with Globigerinæ and other animals, forming chalk at the bottom of the sea, unchanged in structural character, and rigidly conservative in habits and mode of life through the vast geological periods they have witnessed. So, also, there was a time when the hill-sides of Greenland and Spitzbergen, now enveloped in never-melting ice and snows, were, under a genial climate, clothed with forests, in which flourished Taxodium distichum (with Sequoiæ, Magnoliæ, and many others); and when at a later period these forests were destroyed by the general refrigeration, the Taxodium already occupied an area extensive enough to include some districts in which it could still live and propagate; and whatever vicissitudes it may have met with in some parts, or even in the whole, of its original area, it has, by gradual extension and migration, always found some spot where it has gone on and thriven, and continued its race from generation to generation down to the present day, unchanged in character, and unmodified in its requirements. In both cases the permanent animals of the deep-sea bottoms and the permanent trees of the terrestrial forests have witnessed a more or less partial or complete change in the races amongst which they were commingled. Some of these primitive associates, not endowed with the same means of dispersion, and confined to their original areas, were extinguished by the geological or climatological changes and replaced by other races, amongst which the permanent ones had penetrated, or by new immigrants from other areas; others, again, had spread like the permanent ones, but were less fitted for the new conditions in which they had become placed, and in the course of successive generations had been gradually modified by the Darwinian process of natural selection, the survival of the fittest only among their descendants. If, in after times, the upheaved sea-bottom becomes again submerged, the frozen land becomes again suited for vegetation, they are again respectively covered with marine animals or vegetable life, derived from more or less adjacent regions, and more or less different from that which they originally supported, in proportion to the lapse of time and extent of physical changes which had intervened. Thus it is that we can perfectly agree with Dr. Duncan, that 'this persistence (of type and species through ages, whilst their surroundings were changed over and over again) does not indicate that there have *not been* sufficient physical and biological changes during its lasting to alter the face of all things enough to give geologists the right of asserting the succession of several periods;' but we can, at the same time, feel that Dr. Carpenter is in one sense justified in the proposition, that we may be said to be still living in the cretaceous period. The chalk formation has been going on over some part of the North Atlantic sea-bed, from its first commencement to the present day, in unbroken continuity and unchanged in character." — *Amer. Jour. Sci.*

DARWINIAN THEORY OF NATURAL SELECTION.

In his annual address as President of the Canadian Institute, the Rev. Wm. Hincks makes use of the following argument in opposition to the Darwinian theory of Natural Selection: "Nothing is to me more evident than that both seemingly permanent specific and higher *differences*, and varieties which have no pretensions to permanence, depend on the comparative development of different elements of a common plan; from which it seems to follow both that the non-existence from the commencement of living nature of all the distinct plans of structure is in the highest degree improbable, and that the tendency of development, sometimes in one direction, sometimes in another, among the same primitive elements, must produce a harmonious system; whilst the preservation of the forms best adapted to a situation amongst a great number of variations arising without order must produce a confused mass of objects having no regular relations and incapable of being reduced to a common system. Which of these prevails in nature, I cannnot for a moment hesitate in deciding, and consequently I must maintain that, if there is variation, it must be within definite limits, and according to a fixed plan, so as to maintain a uniform order and harmony in the whole system."—*Nature.*

SPONTANEOUS GENERATION.

Spontaneous generation, or heterogeny, is a question which continues to excite much interest. It has been the subject of detailed memoirs, of violent controversies, and of popular articles in this country, and still more on the Continent; but the solution of the problems still involved in doubt does not seem to me to have much advanced since I alluded to the opposing theories of Pasteur and Pouchet in my Address of 1863. The present state of the case appears to me to be this: in the higher orders of animals every individual is known to proceed from a similar parent after sexual pairing; in most plants, and some of the lower animals, besides the result of that sexual pairing which they all are endowed with, reproduction from the parent may take place by the separation of buds, by division, or sometimes by parthenogenesis; in some of the lower Cryptogams, the first stage in which the new beings are separated from the parent is that of spores termed organic, from the belief that they never require previous sexual pairing, although the range of these agamic races is being gradually restricted, a remarkable advance having been recently made in this direction by Pringsheim in his paper on the pairing of the Zoospores in *Pandorina* and *Eudorina.* In all the above cases, in all organized beings which, in their earlier stages, are appreciable through our instruments, every individual has been proved to have proceeded in some stage or another from a similarly organized parent. But there are cases where living beings, Vibrios, Bacteria, etc., first appear under the microscope in a fully formed state, in decaying substances in which no presence of a parent could be detected or supposed: three different theories have been put forward to account for their presence; first, that they are suddenly created out of nothing, or out of purely inorganic elements, which is perhaps the true meaning disguised under the name of spontaneous generation,—a theory not susceptible of argument, and therefore rejected by most naturalists as absurd; secondly, that they are the result of the transformation of the particles of the organic substances in which they are found, without any action of parent Vibrios or Bacteria; and this appears to be what is specially termed heterogeny; thirdly, that there existed in these organic substances, germs which had proceeded from parent Vibrios and Bacterias, but too minute for optical appreciation, and that their generation was therefore normal. The supporters of heterogeny rely on the impossibility of accounting for the appearance of the Vibrios and Bacterias in any other manner; for they say that although you treat the medium by heat in a hermetically closed vessel, in such a manner as to destroy all germs and intercept all access, still these beings appear. This their opponents deny, if the experiments are conducted with proper care. So it was 7 years ago, and so it is still, although the experiments have been frequently repeated in this country, in France, and in North America, almost always with varying results. All reasoning by analogy is still in favor of reproduction from a parent; but heterogeny has of late acquired partisans, especially in Germany, among those who are prepared to break down the barriers which separate living beings from inorganic bodies. — *G. Bentham.* — *Nature.*

PROFESSOR TYNDALL.

Professor Tyndall's most recent contribution to the "germ theory" is contained in a letter to the "Times" of the 7th instant. He has observed that the air breathed out of the lungs, especially at the close of a long voluntary exhalation, is "visibly pure," or produces, when passed across a strong beam of light, the familiar black smoke-like clouds caused by the entire absence of organic matter. He confirms the explanation given by many medical men, and especially by Professor J. Lister, of Edinburgh, for the exclusion of air from fresh wounds, that the putrefaction of wounds is caused by the germination of the germs of organic life contained, under ordinary circumstances, in large numbers in the air. In a reply to this letter in the "Times," Dr. H. C. Bastian makes the startling assertion that, in conjunction with Dr. Frankland, he has met with living organisms in hermetically sealed vessels, from which all air had been removed, and after the contained fluids had been raised to a very high temperature. Some solutions containing organic matter and other ingredients were prepared in the following manner: After a perfect vacuum, above the level of the fluid, had been procured in the glass vessels by means of Sprengel's air-pump, the drawn-out necks of the flasks were closed by means of the blow-pipe flame. The airless flasks, containing then the fluid itself as the only possible germ-containing material, were submitted, in a suitable apparatus, by Professor Frankland, to a temperature varying from 148° C. to 152° C. for 4 hours, and yet, after having been placed under the influence of suitable conditions, in the course of a few weeks, living organisms — many of them altogether new and strange — were found in these fluids. These extremely important results are about to be communicated to the Royal Society. — Nature.

ORGANIC MATTER OF HUMAN BREATH IN HEALTH AND DISEASE. BY DR. ARTHUR RANSOME.

The vapor of the breath was condensed in a large glass flask surrounded by ice and salt, at a temperature of several degrees below zero. The fluid collected was then analyzed for free ammonia, urea, and kindred substances; and for organic ammonia,—the method employed being that invented by Messrs. Wanklyn and Chapman for water analysis. The breath of 11 healthy persons and of 17 affected by different disorders was thus examined, and the results were given in 2 tables. The persons examined were of different sexes and ages, and the time of the day at which the breath was condensed varied. In both health and disease the free ammonia varied considerably; the variation could not be connected with the time of the day, the fasting, or full condition. Urea was sought for in 15 instances, —3 healthy persons and 12 cases of disease; but it was only found in 2 cases of kidney disease, in 1 case of diphtheria, and a faint indication of its presence occurred in a female suffering from catarrh. The quantity of ammonia arising from the destruction of organic matter also varied, possibly from the oxidation of albuminous particles by the process of respiration; but in healthy persons there was a remarkable uniformity in the total quantity of ammonia obtained by the process. Amongst adults the maximum quantity per 100 minims of fluid was 0.45 of a milligramme and the minimum was 0.35. A rough calculation was given of the total quantity of organic matter passing from the lungs in 24 hours,—in adults about 3 grains in 10 ounces of aqueous vapor; a quantity small in itself, but sufficient to make this fluid highly decomposable, and ready to foster the growth of the germs of disease. In disease there was much greater variation in the amount and kind of organic matter given off. In 3 cases of catarrh, 1 of measles, and 1 of diphtheria, the total ammonia obtained was much less than in health, —less than 0.2 of a milligramme; a result probably due to the abundance of mucus in these complaints, by which the fine solid particles of the breath were entangled. In 2 cases of whooping-cough it was also deficient, but as they were both children, the lack of organic matter may have been due to their age. In cases of consumption also the total ammonia was less than in health; but in one case of this disease associated with Bright's disease, a larger amount of organic matter was given off, a portion of it due to urea. In kidney diseases, the largest amount of organic matter of all kinds was found in the breath. The ammonia in one case of Bright's disease was 1.8 milligrammes in 100 minims of fluid, and urea was largely present. Perhaps this fact might be taken as an indication of the need of measures directed to increase the activity of other excretory organs. In one case of ozona or offensive breath, the total quantity of ammonia obtained was greater than in any healthy subject, but the excess was chiefly due to organic matter. One convalescent case of fever was examined, and the total ammonia was found to be deficient. The air of a crowded railway carriage, after 15 minutes' occupation was also tested by this method, and in about 2 cubic feet, 0.3 milligrammes of ammonia and 3 milligrammes of organic matter were found. With reference to the presence of organic matter in the atmosphere, it was pointed out that the subject was in no way a novel one, and that it had, during the last 30 years, been very fully investigated by many observers, more especially by Schwann, Dusch, Schroeder, Helmholtz, Van-den, Broeck, Pasteur, and Pouchet; but it was shown that it is to Dr. Angus Smith that we owe the discovery of the readiness with which living organisms are formed in the condensed breath of crowded meetings, and the determination of the actual quantity of organic matter in the air of different localities. Mr. Dancer's calculation of the number of spores contained in the air was noticed, but a source of error was pointed out in the readiness with which organisms are developed in suitable fluids, even in the course of a few hours. Observations upon the organic particles of respired air had at different times been made by the author.

1. In 1857 glass plates covered with glycerine had been exposed in different places, and examined microscopically. Amongst others in the dome of the borough jail, to which all the respired air in the building is conducted, organized particles from the lungs and various fibres were found in this air.

2. During a crowded meeting at the free trade hall, air from one of the boxes was drawn for 2 hours through distilled water, and the sediment examined after 36 hours. The following objects were noted: Fibres, separate cellules, nucleated cells surrounded by granular matter, numerous epithelial scabs from the lungs and skin.

3. The dust from the top of one of the pillars was also examined, and, in addition to other objects, the same epithelial scales were detected.

4. Several of the specimens of fluid from the lungs were also searched with the microscope. In all of them epithelium in different stages of deterioration was abundantly present, but very few spores were found in any fresh specimen. On the other hand, after the fluid had been kept for a few hours, myriads of vibriones and many spores were found. In a case of diphtheria, confervoid filaments were noticed, and in 2 other cases, 1 of measles, and 1 of whooping-cough, abundant specimens of a small-celled torula were found, and these were seen to increase in numbers for 2 days, after which they ceased to develop. These differences in the nature of the bodies met with probably show some difference in the nature of the fluid given off; but it was pointed out that they afford no proof as yet of the germ-theory of disease. They simply show the readiness with which the aqueous vapor of the breath supports fermentation, and the dangers of bad ventilation, especially in hospitals. Dr. E. Lund and Dr. H. Browne stated that they had also made experiments, the results of which were, in general, confirmatory of those obtained by Dr. Ransome. — *Nature.*

ANÆSTHETICS.

A paper was contributed by Dr. B. W. Richardson, at the meeting of the British Association, on methyl compounds. He said, among other things that had been discovered by the experiments made during the past year with anæsthetical bodies was, that it was possible to remove pain without removing consciousness, although any act performed by the patient was afterwards forgotten; the nervous centre which produced sensibility was affected and paralyzed before those centres which were devoted to consciousness. He thought it very possible they would be able to produce an agency which would produce paralysis of sensation through the body without destroying consciousness at all. In the course of the brief discussion which followed the reading of the paper, Dr. Turnbull said the subject treated by Dr. Richardson was a most important one, and he believed that gentleman's researches would lead to useful practical results in the preparation of remedies. Professor Humphrey, of Cambridge, looked forward to nitrate of amyle becoming a cure for those horrible afflictions, lock-jaw and hydrophobia. With reference to the distinction between the locality of consciousness and the locality of sensation, the professor said he knew an instance in which a lady, under the influence of ether, was aware that she was having the wrong tooth drawn, although she was unable to give utterance to the fact.

THE BRAIN.

Dr. Brown-Séquard, at the meeting of the British Association, in the course of his remarks, said that the series of experiments he had made upon different animals led him to the belief that the right side of the brain was more important for organic life than the left side was. Although the two sides of the brain were precisely alike when the animals were born, by greater development of the activities of one side it came to be quite different from the other.

USE OF ELECTRICITY IN CAUTERIZATION.

The old method of cauterization by fire is to be replaced by the electro-thermic or galvano-caustic apparatus. The latter process is safer and more certain in its operation. It is possible at will to vary the degree of heat, to raise it instantly to the highest intensity, to diminish or suppress it, to render it intermittent or continued, to direct it into deep cavities, and to destroy all the tissues by contact. It is said that the wounds produced by electricity are less liable to contagion and miasmatic infections than those caused by sharp instruments.

The apparatus can be made of any desired shape so as to be applicable to all parts of the body, and it is known that important cures have been effected by the introduction of platinum wires and the cauterization by the battery of parts of the body inaccessible in any other way. Electricity has already been tried in cases of bad tumors, in amputations, in excisions of cancers, in destruction of wens, for opening cysts, for removing internal tumors, upon wounds by fire, and in numerous other cases. And a recent article in "Cosmos" claims for it the following advantages: "The electro-thermic cautery suppresses all pain after the operation; avoids loss of blood; prevents the retention and alteration of the liquids; avoids all putrid and purulent infections; facilitates the organic reconstruction and healing of the parts; affords a method universally applicable, strong or weak, continuous or intermittent; capable of sloughing the tissues, of carbonizing them, of destroying them, of converting them into gas, and must be regarded as one of the most important contributions to modern surgery."

AIR IN TISSUES.

It is a well-known fact in surgery that when air gets into the tissues in consequence of a perforation of the lung by a punctured rib, it does not excite putrefaction or suppuration, as it is apt to do when it acts on an external wound. Professor Tyndall, in a letter to the "Times," connects with this fact his observation, by means of a beam of light, that air expelled from the lungs by a forced expiration contains no floating particles, and considers that together these facts afford a complete demonstration that germs in the air removable by filtration are the cause of putrefaction and its associated phenomena of animalcular life.

PULSE-BEATS.

Dr. Omanza describes a method of registering photographically the beat of the pulse. The apparatus essentially consists of a small inverted funnel, having a long, narrow stem and a caoutchouc base. This instrument is filled with mercury to a certain distance up the stem, and its base is applied to the heart or an artery; the oscillations of the mercurial column are then photographed by well-known processes. It is said that with this apparatus the apparently single stroke of the pulse is shown to consist of three, or even four, in succession. — *Nature.*

LIVING ORGANISMS IN LIMESTONES.

M. Béchamp is the author of an interesting memoir upon this subject, to the French Academy.

He asserts the presence, in the limestones of various geological periods, of living organisms, to which he attaches the name of microzymas.

These microscopic beings he has found not only in geologically modern deposits, but even in those of jurassic age. To their presence, he claims, is due the fact that the various limestones, when brought into contact with starch or sugar solution, cause fermentation to set in; while the same experiment with the highly crystalline varieties of carbonate of lime produces no trace of such a phenomenon.

PLATEAU ON THE FLIGHT OF COLEOPTERA.

M. Felix Plateau has supplemented the recent labors of Marey and others upon the flight of insects by examining the movements of the wings of certain Coleoptera. Specimens of the common May-beetle and *Oryctes nasicornis* were selected for experiment. The apparatus used consisted of 2 pulleys, fastened one above the other, at a distance of 2 centimetres, on a vertical support; the upper pulley made 12 turns for each one made by the lower, and could be caused to rotate 24 times in a second. The insects were killed by ether vapor immediately before each experiment; and the wings could be fastened, by a simple contrivance, to the front prolongation of the axis of the upper pulley. A wing, in its folded state, was fixed on the instrument in such a manner that its plane made with the plane of rotation an angle of 45°, as in the living animal. On turning the pulleys, it struck the air obliquely by its upper surface and front margin; but the small diameter of the apparently continuous revolving disc (as indicated by a graduated scale) proved that the wing was still folded, and that centrifugal force had not affected it. When rotation was produced in an opposite direction, so that the wing struck the air both by its posterior membranous margin and inferior surface, the increasing diameter of the disc gave proof of the expansion of the wing, which, indeed, continued to be much extended when motion was arrested. When the plane of a wing was perpendicular to the plane of rotation, and the revolution of the wheel was such that the wing struck the air by its dorsal or upper surface, no extension ensued; when it struck by its lower surface only partial extension followed. Now the oblique, not the perpendicular, plane is that chosen by nature, and is, as has been seen, much more favorable for flight. On fixing an open wing on the axis so as to make an angle with the plane of rotation, and turning in one direction, the wing remained open; on reversing the direction (that is, acting on the upper surface), it became partially closed. — *Nature*.

HEAT EVOLVED BY INVERTEBRATE ANIMALS, ESPECIALLY INSECTS.

In the "Annales des Science Naturelles," tome XI. (1869), p. 134; "Bibl. Univ.," January 15, 1870; "Bull. Sci.," p. 83, can be found memoirs on the above subject.

Mr. Giraud's researches have been made by various processes. He has employed the mercurial thermometer, the little bulb of which he has succeeded in introducing into the rectum of caterpillars and other insects without injury to the animal. He has also made use of the differential thermometer of Leslie, in which he made a modification necessary for his experiments. One of the bulbs presents a deep interior cavity, so that the volume of air contained in the concentric zone is equal to that of the volume of air in the other bulb. The contracted orifice is closed by a cork furnished with a tube, through which air enters and escapes freely. The insect to be experimented on is introduced into this cavity with the precautions necessary to avoid falsification of the result. M. Giraud has also employed thermo-electric needles formed of iron and copper, or, still better, of iron and platinum, such as already, in the hands of M. Becquerel, have done good service in the study of animal heat. Lastly, M. Giraud has used the theromo-electric piles of bismuth and antimony.

Some of M. Giraud's conclusions are as follows: Adult insects, even when sleeping or very weak, never present a diminution of the temperature of the surface of their body below the surrounding temperature. The larvæ and pupæ of insects, with an imperfect metamorphosis, behave, in this respect, like the adults. Like them, they always present an elevation of temperature above that of the surrounding air, or at least a temperature equal to that of the latter. This is not always the case in insects with a complete metamorphosis. The author has frequently ascertained, in caterpillars with smooth bodies, that the surface descends below the temperature of the surrounding air, which shows that the evolution of heat by the respiratory combustion may be insufficient to compensate for the loss due to superficial evaporation or cutaneous transpiration. The same fact occurs in chrysalids. The cocoon with which the pupæ of a great number of Lepidoptera and Hymenoptera envelop themselves serves to prevent a too rapid desiccation of the animal, which would superinduce a fatal superficial refrigeration. In fact, pupæ present a distinct elevation of temperature at the moment when they are taken out of the cocoon; then, in the air, they lose their weight by evaporation, and the surface of their body often descends below the temperature of the surrounding air. In winter naked torpid caterpillars and pupæ return to the surrounding temperature, or to a very slight excess above it. The superficial refrigerations due to evaporation are not produced when the temperature very nearly approaches 32° F., — a result perfectly conformable with the results of physical researches.

Sex exerts a marked influence on the evolution of superficial heat in certain groups of insects. Thus in the Bombycidæ the males are warmer than the females. Something of the same kind seems to occur among the Phryganidæ and Pieridæ. But we must be careful in generalizing these results. In caterpillars the heat is not localized in a few segments, but belongs to all, which agrees well with the analogous dissemination of the nervous centres. This is by no means the case in insects with powerful aerial locomotion. The variation of temperature shown by them between the thorax and the abdomen may become very considerable. In the humble-bees, and especially in the Sphingidæ, whose flight is so powerful, the excess of the thoracic over the abdominal temperature amounts commonly to from 7° to 11° F., or even sometimes to from 14° to 18° F. We may say that in insects endowed with aerial locomotion the heat is concentrated in the thorax into a focus of intensity proportional to the effective power of flight. These results are in conformity with anatomical data. In the thorax, then, are the strong muscles both of the legs and wings. The latter, being in energetic contraction during flight, are the seat of an active combustion; on the contrary, the muscles of the abdomen are then inert. We must not be surprised that the equalization of temperature does not take place so rapidly as in the vertebrata. If we consider a wasp (a Polistes or a Sphex), the abdomen of which is united to the thorax only by a slender peduncle, how slowly must the currents of the blood be transmitted between these two regions through so narrow a strait! We may see how the heat developed in the thorax during the movement of flight must pass with difficulty into the abdomen, even if it ever reaches this part.

M. Giraud has ascertained that, in the humble-bees and Xylocopæ, the external evolution of heat is in relation to the buzzing. The temperature falls as soon as the insect ceased to buzz, but rises again as soon as the buzzing is resumed; and this takes place many times successively.

INSECT DESTRUCTIVE TO THE SILK CULTURE.

The Secretary of the English Embassy in Japan, Mr. Adams, has lately described an insect called Uji or Oudji, in all its stages from embryo up to full growth, which has become very destructive to the silkworm in Japan. This insect is referred, together with the Chinese fly, to the Diptera. Guerin-menevelle proposes for it the name Tachina Oudji. — *Comptes Rendus, t.* 70, *p.* 844.

THE BORER.

An interesting report on the ravages of the borer in coffee estates has just been published by George Bidie, M.B., F.R.G.S. The coffee-plant, as is well known, is not indigenous to Southern India, but was first introduced into India upwards of two centuries ago by a Mussulman pilgrim, Bababooden, who, on his return from Mecca, brought a few berries in his wallet, and taking up his abode in the hills of Mysore, planted them near his tent, and from these the greater portion of the coffee now growing in Southern India has been derived. It is a native of Caffa, in Southern Abyssinia. It is now largely cultivated in Mysore, Cuddoor, Coorg, and other parts along the crests and slopes of the Ghauts. It is a remarkably hardy plant, thriving at various elevations, and under the most different conditions of moisture, soil, and temperature. It is, however, liable to the attacks of certain insects, amongst which the borer is the most formidable. This is shown by Dr. Bidie to be the larva of a beetle belonging to the *Cerambycidæ*, and termed the *Xylotrechus quadrupes*. The female lays its eggs in the bark of the plants, hot sunshine favoring their hatching. The larva immediately pierces the bark, and derives its nourishment from the more juicy layers, producing, by the damage it causes, exhaustion of the tree and loss of the crop. The whole duration of the life of the animal from the deposition of the ovum to the death of the beetle does not exceed 12 months. The animal appears to be indigenous, and the causes that have led to the great increase in its ravages during the last few years are drought, want of shade, bad culture, destruction of forest trees in which the insect used to live, and departure of some of its enemies. — *Nature.*

ANTISEPTIC TREATMENT OF RINDERPEST AND SCARLET FEVER.

Mr. Wm. Hope (Victoria Cross), at the meeting of the British Association, read a paper "On the Antiseptic Treatment of Contagion as Illustrative of the Germ-Theory of Disease."

Mr. Hope said that on an experimental farm belonging to a company in which he was interested, pecuniarily and scientifically, rinderpest broke out in the summer of 1867 among a herd of 260 or 270 cows. He sent for Professor Brown from the Privy Council, who, after making his inspection, said he had found every symptom of rinderpest except one, and that was one of the later symptoms generally, although not invariably, preceding death, namely, ulceration of the mouth. Next the dreaded ulcers appeared, and Professor Brown told him there were no means of cure known to science; that the disease was practically incurable; that in the present instance there was no sober serious chance of saving a single animal out of the whole herd. At his particular request Professor Brown explained the progress of the disease, and the peculiar difficulties to be encountered. Immediately afterwards he (Mr. Hope) undertook the treatment of one half of the animals. He got all the quicklime he could lay his hands on, with which he formed broad roadways all round the sheds, 3 or 4 inches in depth, and placed pyramids of it along the pathways in the sheds, and slacked it in *situ*, until all the animals were coughing and choking to an alarming extent. He then obtained the report of the Royal Commission on the Cattle Plague, and specially studied the experiments made by Mr. Crookes, F.R.S. He then telegraphed to Manchester for a barrel of genuine carbolic acid, and determined upon combining the two treatments of liquid diet for the purpose of guarding against the secondary symptoms, with what he might term the chemical treatment recommended by Mr. Crookes. "The result was," continued Mr. Hope, "that, while every single animal that I did not take charge of either died or was slaughtered, I succeeded in saving every single animal that I did take charge of; and if you consider the very large scale on which my operations were conducted, the completeness and thoroughness with which the infection had been disseminated throughout the herd, and the fact that rinderpest is the most infectious of all disorders, whether among mankind or the animal creation, known to science, no one can, I think, doubt that the treatment suggested by Mr. Crookes is a radical and complete specific against rinderpest. What I wish to call the attention of the section to is the fact that I saved the lives of those animals not by any medical treatment, properly so called, of the animals themselves, but by an unremitting, ceaseless chemical onslaught on the germs of the disease. I argued in my own mind that a theory such as the germ-theory of disease could not, in the nature of things, be partially true; it must either be altogether true or altogether false. If true, it was the most hopeful theory that any one could comfort himself with in face of an outbreak of zymotic disease, because it afforded some firm and sure foundation for treatment. A purely medical treatment, properly so called, of infectious disease always has appeared to me — if I may be pardoned for the expression of so heretical an opinion in such orthodox company — to be empirical to the last degree. It is probable that medicines act physically as well as chemically; but I am not aware that any one has been able to give a very satisfactory explanation either of the physical or the chemical action of organic medicines, whether exhibited in the human subject or in a lower organism. The chemical action of many inorganic medicines is no doubt perfectly understood, but even the administration in the nursery of a home-prescribed dose of rhubarb and magnesia has always seemed to me the height of empiricism. For here the nurse boldly invites the actions of inorganic and of organic substances, although no doubt she exhibits her agents with, on the whole, a happy result. But, at last, we appear to be getting upon some firm scientific footing, for clearly it is more scientific to attack the germs producing diseases with a chemical agent whose action is ascertained than to exhibit in the inside of the patient affected a variety of organic and inorganic substances which can only at best act upon the disease, that is, upon the germ, through the secondary agency of the patient himself. Of course in rinderpest, or in any other infectious disease, the disorder may have proceeded too far before the patient is taken in hand to admit of the possibility of a cure, and death may result from a secondary action set up during the progress of the disease, even although the primary cause of the disease, that is, the germs, may have been altogether exterminated. But it has always seemed to me that this case of the chemical treatment of rinderpest upon so large a scale is one of the most entirely practical proofs of the germ-theory of disease that has yet been obtained, and it is for this reason that I have ventured to communicate these details to this section. But in doing so I am anxious to explain distinctly what it is that I mean by the words 'germ-theory of disease,' for the words are so often used that many persons attach various meanings to them. By the 'germ-theory of disease' I simply mean the process by which an infectious disease having once originated is disseminated and communicated from one subject to another. I do not desire to apply it in any way to the *origin* of such diseases. Probably we shall never know the truth as to their origin, for it is difficult to see how any accurate observations can be conducted upon such a point. I therefore wish Mr. Crookes' chemical treatment for infection, as successfully carried out in the case above described, to be considered as evidence only in favor of the theory that infectious disease is propagated, not originated, on what is known as the germ-theory. Of the origin of such diseases I will merely say this, — that I have the greatest possible difficulty in believing that the germs of Asiatic cholera existed in a passive state from the creation of the world, whenever that may have been, — on which point again I would offer no opinion, for I fear that I am getting on dangerous ground, — down to the year 1817, when suddenly called into existence by getting into the congenial climate of a Hindoo stomach. Perhaps I should now communicate a further experiment that circumstances forced upon me in the chemical treatment as disease attacking, as distinguished from medical treatment of the patient attacked, in this next instance, as I am almost afraid to confess, in the human subject. Turning again to the paper from which I read an extract, I will read a prophecy which I was rash enough to publish at the end of it, in, as you will recollect, the month of November, 1867, that similar treatment would, for similar reasons, prove equally successful in diseases attacking human beings."

After reading the passage in question, Mr. Hope proceeded to say: "In the spring of the following year, namely, 1868, I returned home late one Saturday evening, and found to my horror that my eldest child was laid up with a violent attack of scarlet fever. It so happened that scarlet fever was the disease, of all others, that I the most dreaded for children; and this was a violent attack, with acute symptoms both in the throat and of fever. My wife, however, having authorized the exhibition of carbolic acid, and having already isolated the child, I proceeded chemically to attack his enemy, the scarlet-fever germs. The first step was to kill the germs which caused the pain in the throat and the difficulty in swallowing. This was effected by a gargle of 1 part of carbolic acid — I mean of the pure white carbolic acid manufactured by Calvert — to 200 parts of water. The effect was instantaneous, and the result most encouraging. Our efforts were redoubled. We attacked the germs in every direction, and showed them no mercy. Cloths dipped in a 2 per cent. solution of carbolic acid were hung up over the bed and in different parts of the room. The same 2 per cent. solution was sprinkled over the bedclothes and over the carpet and furniture. A basin of the same was always kept at the door of the dressing-room, through which alone ingress and egress were permitted, so that the few persons allowed to come into the room might wash their hands in it before going to other parts of the house. During all Sunday, and all Sunday night, the same treatment was incessantly kept up, and the patient took occasionally small slips of a solution as weak as 0.2 to 0.3 per cent., and the poor germs of the scarlet fever could not get any rest, and could find no place of security. The result was that when the Monday morning came the patient was fast approaching convalescence. I should mention that some very simple febrifuges had been given to the patient, in addition to the carbolic acid which had been administered to the disease. I have not preserved a record of how these were given, but I am quite sure that if I had, there is no one in this room who would say that they were sufficient by themselves to cure a bad case of scarlet fever. Convalescence proceeded most satisfactorily. When the peeling stage arrived the entire skin of the child was washed all over from time to time with a 1 per cent. solution of carbolic acid, and he eventually made a perfect recovery without a relapse, and without any of those dreaded after-consequences which are so disastrous in many cases. Before, however, he could have been certified as safe for other children to approach, some members of the household displayed a somewhat rebellious spirit towards the restrictions imposed on communication with the invalid; and on my return from London one evening I was shocked to learn from my wife, who understood the danger, that several such visits had been paid to the patient when she was off sentry. Up to that time, — the patient having been at once isolated, and rigorous measures of disinfection carried out all through the house, as well as in the sick-room, — the infection had not spread. But I said at once that all our previous care was now thrown away; and it proved to be the case, as in a few days the other children were all attacked also. But the enemy being in their case fiercely assaulted by carbolic acid on his very first appearance, their cases were much milder than the first attack. In the case of a child of about one year old the carbolic acid was applied to his throat by the steam of hot water, which he was made to inhale in every instance with the happiest effect. Eventually the disease was entirely burnt out; the recoveries were in each case most satisfactory, and in no case were there any bad after-results. This instance by itself would not, of course, carry very much weight, but following a case on so great a scale as that I previously described, and the treatment being the direct consequences of the former, and based upon a distinct and intelligible theory, I have thought that you would consider it also of some interest."

The chairman said that, however valuable the effects of the experiments carried on by Mr. Hope might be as a fact, there was a great deal more to be done before they could come to the conclusion that this antiseptic treatment was a proof of the germ-theory. He thought he understood Mr. Hope to say that the chemical action of inorganic medicine was tolerably well understood, and he wished to contrast that with the action of organic medicine, such as rhubarb. He did not know, but he thought Mr. Hope must be in possession of more information concerning the chemical therapeutic of the medicines on the body than he (the chairman) was. Nothing puzzled him more at the present moment than the therapeutic action of such a simple thing as a dose of common salts.

Dr. Baylis, medical officer of health for Birkenhead, said he had had considerable experience during the last 3 or 4 years of the utility of carbolic acid as a disinfectant. He regarded the effects of the experiments made by Mr. Hope as very valuable so far as they tended to illustrate the effects of carbolic acid, as he thought they might fairly draw from them, whatever might be the germ-theory of disease, that carbolic acid did possess very considerable power in the case of one zymotic disease, namely, the rinderpest. Mr. Hope's testimony was not single upon this point; but it must not be inferred that that which was successful in one zymotic disease would necessarily be successful in another. He was, however, inclined to give Mr. Hope's theory respecting scarlet fever the same approval which he had given it in the case of rinderpest. They all knew that children had recovered from scarlet fever in an extraordinary and unaccountable way. Perhaps no treatment was better for this disease than cleanliness,. and fresh air and water. Mr. Hope had made the broad general statement, with regard to the effect of medicine on the human family,that it was purely empirical. Well, they had empirical medicines; they had medicines they knew the effect of, and they had diseases they could cure without medicines. Therefore Mr. Hope's assertion must not be taken generally that the action of medicine was not well understood. With regard to the effect of carbolic acid, Dr. Baylis mentioned that in Birkenhead it had long been his practice in every case where zymotic disease occurred, in the poorer part of the town, to have the acid very freely scattered over the stairs of the houses, into which it sank, and could not be washed out again for many days. The walls of the houses were also washed down with wash containing a portion of the acid, and it had been found that these precautions were very effectual in preventing the spread of the disease; in fact, he could state that fever seldom followed when these precautions had been taken. In conclusion, Dr. Baylis said he thought this general way of treating so important a subject as this was not a satisfactory one, and he thought the association should anticipate the wants of the age. They were unable to settle the germ-theory; he believed in it, but it was impossible at the present time to arrive at any definite conclusion respecting it. Therefore he thought that the department, in which they were now met, should consider it their duty, and he hoped they would feel it to be seasonable, between now and next year's meeting to institute some experiments with regard to the action of disinfectants. They knew that many of them were very useful, but they had no knowledge of how they acted.

Dr. Cobbold said that it was an assumption that germs existed in rinderpest, for they had never yet been seen.

Mr. Hope, in reply to the various speakers, said the theory of the action of carbolic acid was this, — that, being an acid only technically, so to say, it was really caustic and exceedingly volatile; and, therefore, always assuming that the germs of the disease did exist, the action of the acid would simply be the caustic action of burning the mouth. He did not wish to put the case of rinderpest he had mentioned forward as a proof of the germ-theory, although he regarded it as one of the best proofs that had yet been obtained. He then went on to say that there might be simple germs inherent in the body, although it was very difficult at the present moment to know how to get at them. As to the effect of organic *medicines* being understood, he did not mean his remarks to apply to the whole of those medicines, but only to some of them. He thought the case he had instanced of the cattle plague being so complete, and being on so large a scale, — he having saved the whole of the animals he had taken under his charge, while those in the same herd that were not treated by him were sacrificed, — amounted to something like proof of the theory upon which the recoveries were effected.

RELATION OF PIGMENT CELLS TO CAPILLARIES.

The "Lancet" has called attention to some valuable researches of Dr. Saviotti, which we should be sorry to omit noticing. The observer was engaged in studying the inflammatory process in the foot of the frog, and he first obtained a circumscribed spot of inflammation by means of a drop of collodion, and after a few days found the pigment cells of the irritated spot accumulated around the vessels in a contracted condition, and in the course of a short time that they had entirely disappeared. He immediately applied himself to the question of explaining the mode of their disappearance. In other frogs he excited inflammation by dropping on the web a small quantity of a 2 per cent. solution of sulphuric acid. Again, after a few days, he saw that the pigment cells had accumulated around the blood-vessels, and that, though they still preserved their contractibility, their processes were less branched and numerous than natural. On further examination, he now observed that these processes began to penetrate the walls of the adjacent capillaries and small veins, causing an obstruction to the onward movement of the red corpuscles on their proximal side, while a clear space was observable on their distal side, occupied only by serum. And now one of two things occurred: either the process of the cell broke off, and was swept away by the blood current, or the whole cell gradually squeezed itself through the capillary wall (the part within the vessel becoming greatly attenuated and elongated) until it also was carried away. In the former case, the cell, shorn of part of its substance, still remained outside the vessel; in the latter, it of course disappeared entirely. As regards the time occupied in these phenomena, Dr. Saviotti finds that the cell processes penetrate the vessels in a period varying from 3 to 6 hours, and that it takes about the same length of time for the whole cell to follow and to be washed away from the internal surface, to which it long remains adherent. — *Science Review.*

THE ACTION OF ALCOHOL ON THE BODY.

Dr. Parker and Dr. Wollowiez have published, in the "Proceedings of the Royal Society," a very valuable paper, from which we take the following: It appears, then, clear that any quantity over 2 ounces of absolute alcohol daily would certainly do *harm* to this man (the subject of the experiment); but whether *this*, or even a smaller quantity, might not be hurtful, if it were continued day after day, the experiments do not show. It is quite obvious that alcohol is not necessary for him; that is, that every function was perfectly performed without alcohol, and that even 1 ounce in 24 hours produced a decided effect on his heart, which was not necessary for his health, and, perhaps, if the effect continued, would eventually lead to alterations in circulation, and to degeneration of tissues. It is not difficult to say what would be excess for him; but it is not easy to decide what would be moderation; it is only certain that it would be something under 2 fluid ounces of absolute alcohol in 24 hours. It will be seen that the general result of our experiments is to confirm the opinions held by physicians as to what must be the indications of alcohol both in health and disease. The effects on appetite and on circulation are the practical points to seize; and, if we are correct in our inferences, the commencement of narcotism marks the point when both appetite and circulation will begin to be damaged. As to the metamorphosis of nitrogenous tissues or to animal heat, it seems improbable that alcohol in quantities that can be properly used in diet has any effect; it appears unlikely (in the face of the chemical results) that it can enable the body to perform more work on less food, though by quickening a failing heart it may enable work to be done which otherwise could not be so. It may then act like the spur in the side of a horse, eliciting force though not supplying it. — *Science Review.*

EFFECTS OF COMPRESSED AIR ON THE MEN EMPLOYED IN THE CAISSON OF THE EAST PIER OF THE ST. LOUIS BRIDGE.

The first symptom manifesting itself, caused by the pressure of the air, is painfulness in one or both ears. The eustachian tubes, extending from the back of the mouth to the bony cavities over which the drums of the ears are distended, are so minute as not to allow the compressed air to pass rapidly through them to these cavities, and when the pressure is increased rapidly the external pressure on the drums causes pain. These tubes constitute a provision of nature to relieve the ears of such barometric changes as occur in the atmosphere in which we live. The act of swallowing facilitates the passage of the air through them, and thus equalizes the pressure on both sides of the drums, and prevents the pain.

The pressure may be admitted into the air-lock so rapidly that this natural remedy will not in all cases relieve it. By closing the nostrils between the thumb and fingers, shutting the lips tightly, and inflating the cheeks, the eustachian tubes are opened, and the pressure on the inner and outer surfaces of the tympanum is equalized, and the pain prevented. This method must be used and repeated from time to time as the pressure is let on, if it be increased rapidly. No inconvenience is felt by the reaction when the pressure is let off, as the compressed air within the drums has a tendency to open the tubes, and thus facilitates its escape through them; whereas, increasing the pressure has the effect of collapsing them, and therefore makes it more difficult to admit the compressed air within the cavities of the ears. It frequently occurs, however, from some abnormal condition of these tubes, as when inflamed by a cold in the head, that neither of these remedies will relieve the pain. To continue the admission of compressed air into the lock, under such circumstances, would intensify the suffering, and possibly rupture the tympanum; therefore the lock-tenders were particularly instructed to shut off the compressed air at the moment any one in the lock experienced pain about the ears; and then, if it could not be relieved by the above means, the lock was opened, and the person was not permitted to go through into the air-chamber. Sometimes 15 minutes were occupied in passing persons through the first time, after which they usually had no further trouble from this cause.

The fact that the depth penetrated by the air-chamber was considerably greater than that hitherto reached in any similar work, left me without any benefit from the experience of others in either guarding against any injurious effects of this great pressure upon the workmen and engineers subjected to it, or of availing myself of any known specific for relieving those affected by it.

When the depth of 60 feet had been attained, some few of the workmen were affected by a muscular paralysis of the lower limbs. This was rarely accompanied with pain, and usually passed off in the course of a day or two. As the penetration of the pier progressed, the paralysis became more difficult to subdue. In some cases the arms were involved, and in a few cases the sphincter muscles and bowels. The patients also suffered much pain in the joints when the symptoms were severe. An average of at least 9 out of 10 of those affected suffered no pain whatever, but soon recovered, and generally returned to the work.

The duration of the watches in the air-chamber was gradually shortened from 4 hours to 3, and then 2, and finally to 1 hour.

The use of galvanic bands or armor seemed, in the opinion of the Superintendent of Construction, the foreman of the chamber, and the men, to give remarkable immunity from these attacks. They were all ultimately provided with them. These bands were made of alternate scales of zinc and silver, and were worn around the wrists, arms, ankles, and waist, and also under the soles of the feet. Sufficient moisture and acidity were supplied by the perspiration to establish galvanic action in the armor, and, as the opinion of those most accustomed to the chamber was almost unanimous in favor of this remedy, I am very much inclined to believe it valuable.

Immediately on the manifestation of greater severity in the symptoms, a hospital-boat was fitted up at the pier, and one of the ablest physicians in the city (Dr. A. Jaminet) was engaged to attend those affected, and also to institute such sanitary measures as his judgment should dictate. A careful examination of the health and bodily condition of every workman was daily made, and none were permitted to engage in the work without the approval of Dr. Jaminet. Those most severely affected were sent to the city hospital, and had the benefit of the advice and treatment of its resident physician, Prof. E. A. Clark.

The total number of men employed in the air-chamber of this pier was 352. Of this number, about 30 were seriously affected. Notwithstanding the care and skill with which those most severely attacked were treated, 12 of the cases proved fatal. Each one of these, without exception, I believe, was made the subject of careful inquest by the coroner, aided by an autopsy conducted usually by some of our most skilful surgeons and physicians.

Whilst the exciting cause in all of these cases was doubtless the exposure of the system to the pressure of the condensed air of the chamber, the habits and condition of several of those who died were, at the time they went to work, such as would have excluded them from it if subjected to the examination of Dr. Jaminet, and the verdict in about one-half of the cases gave a totally different cause for the death of the patient. Nearly or quite all of these deaths happened to men unaccustomed to the work; several of them to men who had worked but 1 watch of 2 hours. In contrast to this, is the fact that quite a large number of the men (certainly one-half of those constantly employed) commenced with the work at its inception, and remained throughout its continuance entirely without injury or inconvenience.

The gentlemen composing the engineer corps of the bridge all visited the air-chamber, some of them quite often, either in the discharge of their professional duties, or from motives of curiosity, and none of them suffered any injury whatever.

Much diversity of opinion was expressed by the medical gentlemen who investigated the symptoms and held autopsies of the deceased. Some of these gentlemen maintained that a slower transition from the abnormal to the natural pressure would have been less injurious; others claimed, on the contrary, that it was from the too rapid application of pressure in passing from the natural into the compressed air. The fact that the air-lock tenders were in no case affected, although subjected many times during a watch of 2 hours in the air-lock to rapidly alternating conditions of the atmosphere, at one moment in its normal state in the lock, and 5 minutes later exerting a pressure of 50 pounds per square inch upon every part of the body, would seem to prove both of these theories unsound, and lead us to believe that in the length of time to which the human system is subjected to this extraordinary pressure exists the real source of danger, and not from any rapid alternations of pressure to which it is exposed.

After the caisson reached the rock, I have frequently, when passing through the air-lock, admitted the compressed air into it so quickly that none but those well accustomed to it could relieve the pressure upon their ears, and yet I felt no ill effects whatever from this rapidly increased pressure; and in going out I have let the pressure off so fast that the temperature in the lock has fallen 32 degrees (F.) in consequence. These transitions occupied but 3 or 4 minutes.

The fact that the air-chamber was briefly visited by thousands of persons, including many delicate ladies, even after it had reached the bed-rock, some remaining as long as an hour in it without any of them experiencing the slightest ill effects from the pressure, and the fact that no cases of any importance whatever occurred among the workmen after the watches were reduced to 1 hour, satisfies me that this is the true cause of the paralysis, and that, by lessening still more the duration of the watches, a depth considerably greater can be reached without injury to the workmen. Too long a continuance in the air-chamber was almost invariably followed by symptoms of exhaustion and paralysis. Dr. Jaminet, on one occasion, remained in 2¾ hours when the depth was over 90 feet, and was dangerously attacked soon after reaching home. —*From the Report of the Chief Engineer, Capt. James B. Eads.*

ICONO—PHOTOGRAPH ALBUM.

An icono-photograph album, containing numerous figures of the appearances presented by sections of the nervous centres, has just been presented by Dr. Ducheune; of Boulogne, to the French Academy of Medicine. He states he has obtained excellent results from sections of the great sympathetic nerve, the spinal ganglia, the spinal cord, and of the medulla oblongata, when magnified from 8 to 500 times. The plan was suggested some years ago by Dr. Ducheune himself, but it was found that the photographs obtained in the ordinary method were not persistent. He therefore fixed them on stone, by a process he terms photo-autography, the details of which, however, he does not communicate. It is satisfactory to find him stating that the results of his experiment and photographs only confirm the substantial accuracy of the beautiful drawing made by Dr. Lockhart Clarke on the central parts of the nervous system, and especially upon the medulla oblongata. In his later experiments Dr. Ducheune has adopted Dr. Clarke's mode of preparation with chromic acid and carmine. He states that certain micrographic details come out with wonderful clearness in the photographs, and that by this means some important additions may be made to our knowledge. Thus he has ascertained that in the white substance of the medulla oblongata there are a large number of very small nerve tubules (0.0033 m.m.) diameter mingled with others of average and of large diameter 0 m.m, 0 1 to 0 m.m, 02 and .0.3. —*Nature.*

SKIN GRAFTING.

We have already referred, at some length ("Lancet," July 7th, 1870), to the interesting experiments which are being carried out at St. George's Hospital, by Mr. George Pollock, in reference to the process introduced by M. Reverdin, of promoting the healing of ulcerated surfaces by grafting upon them small pieces of healthy *epidermis.* On Tuesday last we saw Mr. Francis Mason, at the Westminster Hospital, attempt an adaptation of the process to a recent raw surface. The patient was a young woman whose chin and lower lip were drawn down by strong bands of cicatrix from an extensive burn, producing a terrible and increasing deformity. The plan of operation adopted was a combination of the old one by division of cicatrix with the novel feature devised by M. Reverdin. By division of some strong bands and dissection of adherent integuments, the skin about the lower part of the face and upper part of the throat was released, at the expense of 2 large raw surfaces, which were now left lower down. It was upon these that Mr. Mason next proceeded to engraft 6 or 8 pieces of skin, which he snipped off of the lax abdominal tegument. They were not bigger than the half of a small pea, and they were planted by simply laying them on the raw surface, and retaining them in position by transparent plaster. The hope is that these patches of skin may form centres from which integumentary growth may spread in every direction, and thus materially diminish the time which would otherwise be required for the healing of such large surfaces by unaided granulation. Success has attended the process as performed upon old granulating surfaces; it remains to be seen whether a similar result will obtain where, as in this instance, the surface which receives the grafted skin is a raw one recently exposed by dissection. We shall watch this interesting case, and report its progress on a future occasion. — *Lancet, Aug. 27th,* 1870.

A NEW ANTISEPTIC.

The hydrated chloride of aluminium, to which Mr. John Gamgee has recently drawn the attention of medical men and of the general public, appears to be a valuable antiseptic. It is quite as potent as chloride of zinc or carbolic acid, and is at the same time non-poisonous, and devoid of unpleasant smell of any kind. These qualities will no doubt ensure its being extensively used, and at no distant date we may expect it to displace the antiseptics which are at present in vogue. It is somewhat strange that this substance should have been so long overlooked as a possible antiseptic, and Mr. Gamgee certainly deserves credit for suggesting the utilization of it for this purpose. The reason why it has been passed over is probably to be sought in its not being a waste product in any common chemical manufacture. The anhydrous chloride of aluminium, which is manufactured in order to serve for the preparation of metallic aluminium, is far too costly, on account of the troublesome nature of the process by which it is prepared, — to wit, by passing chlorine at high temperatures over a mixture of aluminium and charcoal. By placing the anhydrous chloride of aluminium in water, it is of course converted into hydrated chloride. The most economical process for the preparation of the hydrated chloride of aluminium appears to be by double decomposition between sulphate of alumina and chloride of calcium (both of which are cheap commercial products). When solutions of these two salts are mixed together, sulphate of lime is formed, and appears as a precipitate, whilst the hydrated chloride of aluminium remains dissolved. On allowing the aqueous solution to evaporate at a very gentle heat, and afterwards cooling, crystals of hydrated chloride are produced. If an attempt be made to drive off the water from hydrated chloride by the application of heat, decomposition will take place. Hydrochloric acid is evolved under these conditions, and oxychloride of aluminium is formed, and, by pushing the process, alumina is obtained as the ultimate fixed product. — *The Lancet.*

A NEW SPHYGMOSCOPE.

In the "Centralblatt" of the 25th of June, M. Landois gives an account of a new sphygmoscope, which so far differs in construction from those that have been hitherto suggested that the movements of the pulse act on a column of gas, the undulations of which can be recognized by the movements of the flame resulting from the ignition of the gas as it issues. M. Landois observes that the nature of the dichrotic curve or secondary elevation in the pulse, so commonly depicted, has not as yet been satisfactorily determined; some believing it to be a real undulation, others that it is to a certain extent an artificial curve, and due to a kind of recoil of the instrument. None of the tracings obtained by the various forms of instruments hitherto suggested are free from this peculiar undulation, whether we take the mercurial column, as in the instrument of Chelins; the column of water, as in that of Naumann; the elevation of a lever, as in that of Veerordt; or, lastly, a spring, as in that of Marey. The instrument suggested by M. Landois appears to be a small metal chamber, the edges of which fit closely on the wrist or elsewhere, whilst a small space is left between the skin and the inside of the chamber, through which either ordinary gas or hydrogen is transmitted from a gasometer at a very low pressure. The gas issues by a capillary glass tube attached to the other extremity of the chamber, and can easily be ignited. It is interesting to find that the movements thus rendered visible agree precisely, both as regards the principal curve and the secondary undulation, with those exhibited by means of Marcy's sphygmograph. — *The Lancet.*

THE VALUE OF AMERICAN HEMP IN MEDICINE.

Dr. H. C. Wood, Jr., has written an essay, which he read before the American Philosophical Society, in which he records some experiments with an article of hemp grown in Kentucky. He took an alcoholic extract made from the dried leaves, swallowing at a dose nearly all the product of an ounce and a half of the leaves, with the effect of profound hemp intoxication. It proved to be toxic in its power, although he recovered himself in a day or two. He had all the exuberant hilarity usually experienced from the hemp, followed by a feeling of fear of impending death;

this took so deep a hold on him that it was impossible to shake it off.

Other trials he has made with it convince him that it has more power than that brought from India, — on one occasion four times the dose of the latter failing to produce the effect of the Kentucky specimen.

He has his extract made from a tincture, removing certain inert matters by an akali; he intimates the hope that in the present revision of the U. S. Pharmacopœia the *ex. cannibis purifactum* may be replaced by a preparation to be called *Resena cannibis*, and to be made by precipitating the concentrated tincture by water rendered strongly alkaline by soda or potash.

The native plant, if used, will always be more reliable than the imported, from the certainty of freshness, whilst the cost of it is hardly anything.

PHYSIOLOGICAL EFFECTS OF CARBONIC ACID.

At the meeting of the British Association a paper was read by Dr. B. W. Richardson, entitled "New Physiological Researches on the Effects of Carbonic Acid." In the course of an interesting communication he explained that the observations he had made were new, in that they related to the direct action of carbonic acid on animal and vegetable fluids, and they were interesting equally to the zoölogist and botanist as to the anatomist. The author first demonstrated from a specimen the result of subjecting a vegetable alkaline infusion to the action of carbonic acid under pressure. The result was a thick fluid substance, which resembled the fluid which exudes as gums from some trees. When this fluid was gently dried it became a semi-solid substance, which yielded elastic fibres, and somewhat resembled conachone. This observation had led the author to study the effect of carbonic acid on albumen, serum of blood, blood itself, bronchial secretion, and other organic fluids. When the serum of blood was thus treated with the carbonic acid under pressure and gentle warmth, 26° F., the colloidal part was separated; but when the blood, with the fibrine removed from it, was treated, there was no direct separation, the blood corpuscles seeming for a time to engage the gas by condensation of it. But blood containing fibrine, and holding fluid by tribasic phosphate of soda, was at once coagulated by the acid. The bronchial secretion was thickened by carbonic acid, and a tenacious fluid was obtained, resembling the secretion which occurred in asthma and bronchitis, while secretions on serous surfaces were thickened and rendered adhesive. After detailing many other facts, Dr. Richardson concluded by showing what bearing this subject had of a practical kind. In the first place, the research had relation to the question of elasticity of organic substances; and, secondly, on the direct action of carbonic acid on the production of vegetable juices. But the greatest interest concentrated on the relation of the research to some of the diseases of the animal body.

Thus, in instances where the temperature of the body was raised, and the production of carbonic acid was excessive, the blood on the right side of the heart had its fibrine often precipitated, and in many other cases fibrinous or albuminous exuded fluids were solidified, as was the case in croup. The author, in the course of his paper, explained how rapidly blood charged with carbonic acid obsorbed oxygen when exposed to that gas; and he held that carbonic acid in the venous blood was as essential to the process of respiration as was the oxygen in the pulmonary organs.

FERTILIZATION OF FLOWERS BY INSECTS.

This is the title of an original paper by Dr. William Ogle, in the April number of the "Popular Science Review."

The fertilization of the Heath family is treated in a very interesting manner. The writer describes the use of the arms or appendages on the back of the anthers in Heaths, by which the bee moves the anther so that the pollen falls out upon the insect's head. The fertilization of papilionaceous blossoms, particularly bean flowers, is also treated of. The writer notes that some bees get at the nectar by making a hole in the side of the calyx tube, while others enter by the regular way; an individual bee keeps persistently to one or the other mode in visiting a number of bean flowers. "It would thus appear that the habit is not an instinct, belonging by inheritance to the whole species, but is in each case the result of individual experience. As others have not, we must admit not only that these insects are intelligent, but that they differ from each other in their degrees of intelligence, some being slow in acquiring knowledge, others quicker." — *Editor*.

CROSS-FERTILIZATION AND LAW OF SEX IN EUPHORBIA.

Mr. Charles Darwin's interesting observations on cross-fertilization have opened a new world for original discovery. The list of plants which seem to avoid self-fertilization is already very large. I think *Euphorbia* may be added to the number. Certainly this is the case with *E. fulgens*, Karw. (*E. jacquinaflora*, Hook), which I have watched very closely in my greenhouse this winter. Several days before the stamens burst through the involucre, which closely invests them, the pistil with its ovarium on the long pedicel has protruded itself beyond, exposed its stigmatic surfaces, and received the pollen from the neighboring flowers. The way in which the pollen scatters itself is curious. In most flowers a slight jar or a breath of wind will waft the pollen to the stigmas, but I have not been able to notice any to leave the flowers in this way; for as soon as the anther cells burst, the white stamen falls from its filament-like pedicel, and either drops at once on the pistils of other flowers or scatters its pollen grains by the force of the fall. This *Euphorbia* also furnishes another contribution to the theory of sex which I have advanced. The plan on which the male and female organs are formed is evidently a common one; and the only reason why some flower-heads have a pistil in the centre, and others are wholly staminate, is, that there is greater axial vigor when the female flower is formed. Whenever the common peduncle (below the scarlet involucre) is weak, a pistil never appears in that head of flowers. A few which seem strong neither have them; but the great majority of the strong peduncles are those which bear the female blossoms. Another interesting fact is that the number of male flowers is less in those heads which also bear a female than in those which are wholly staminate. This seems to add to the point I made in my paper on *Ambrosia*, that after the flowers have been partially formed in embryo, and before the sex has been finally determined, the female flower, being primordially the stronger, has the power of absorbing the males, or their partially formed elements, into its system. It is certainly remarkable that in both these instances the number of male flowers should decrease in proportion to the existence or vigor of the central female one. The male and female flowers of *Euphorbia fulgens* are formed much alike; the female occupies the centre, and seems really but a prolongation of the main stem, on the top of which is an articulation from which the ovarium springs. The capsula readily falls from this articulation when mature. From the base of the female central peduncle spring weaker peduncles, colorless, appearing, indeed, almost like filaments, articulated at about the same height as the female, only above the point bearing a short filament and anther, — the caduceous part before referred to. No one can fail to see the correspondence of plan in these different parts, and I think that nothing but the favorable position in the direct line of axial vigor made the central flower a female one. Cases occasionally occur in which a tolerably strong head of wholly male flowers will develop the central axis into a pedicel almost as long and vigorous as those which bear female flowers. But the flow of vital force — if I am correct in using this term — not being quite sufficient, the final goal of natural perfection in the female form was not reached. These cases do not occur often, but are well worth looking for, as they show so clearly the dividing line between the forces which govern the male or female sex. — *Abstract of a paper read by Thomas Meehan before Phil. Academy of Natural Sciences.*

MOVEMENTS OF CHLOROPHYLL.

A series of observations have been made by Prillieux, Rose, and Brongniart, on the apparently spontaneous movements within the leaves of plants of the grains of chlorophyll which constitute the green coloring matter. These grains had been noticed by previous observers to congregate under the direct action of light. M. Prillieux performed his experiments on a species of moss. When the moss had been kept in the dark for some days, the cells presented the appearance of a green net-work, between the meshes of which was a clear, transparent ground. All the grains of chlorophyll were attached to the walls which separate the cells from one another; there were none on the upper or under walls which form the surfaces of the leaf. Under the influence of light the grains change their position from the lateral to the superficial walls, the movement taking place, under favorable circumstances, in about a quarter of an hour. On attaining their new position, the grains do not remain entirely immovable, but continually approach and separate from one another. If again darkened, they leave their new position, and return to the lateral walls. Artificial light produces the same effect as daylight. A protoplasmic material is intimately associated with the grains of chlorophyll, causing them to move in masses of net-work rather than in isolated grains; and this protoplasm is supposed to be the vital and animating part of the cell.—*Quarterly Journal of Science.*

GIRDLING FRUIT–TREES TO MAKE THEM BEAR.

A correspondent of the "Boston Journal of Chemistry" states that there is no doubt that the girdling of fruit-trees is a cause of abundant fruitage; but it by no means follows from this fact that a general principle can be deduced, that trees would be improved, or the crop increased for a series of years, by such treatment. It is well known that gardeners frequently girdle a branch, by removing a narrow ring of bark around it, when they wish to increase the size and beauty of the fruit; but it is done at the expense of its vitality, and, unless the operation is skilfully performed, will invariably destroy it before the season of bearing the next year.

The crude sap, taken up from the soil by the roots of the tree, ascends principally through the vascular tissue of the alburnum or sap-wood to the leaves of the branches, and there both this and the carbon of the carbonic acid, absorbed from the air by the leaves, are organized into the proper substance for the growth of the wood and fruit. It then descends on the outside, principally through the sieve tissue of the cambium layer, forming a new layer of wood and bark; while a part also goes to the nourishment of the fruit. If there is no obstruction of the elaborated sap in its downward course, it is equally distributed to the branches, fruit, stem, and roots; but if the bark and cambium layer are removed by girdling, it is stopped in its descent, and consequently received into the branches and fruit in excess, and they are thus increased at the expense of the part below. In this way we account for the increase of the fruit by girdling.

Professor John Lindley, when speaking of this subject in his late treatise on horticulture, quotes Mr. T. A. Knight approvingly, as follows: "When the course of the descending current is intercepted, that naturally stagnates, and accumulates above the decorticated space, whence it is repulsed and carried upward, to be expended in an increased production of blossoms and fruit." This theory is adopted by the best physiologists of the present time, and can be demonstrated with almost mathematical certainty. Therefore, this unnatural development of fruit, instead of indicating an improvement of the trees, must be looked upon as a premonitory symptom of disordered physical action, and of premature death.

If the bark and the cambium layer have been removed by girdling, as seems to be the case with the trees, the downward circulatory connection on the outside between the upper and the lower part is destroyed, and the upper part at least must die. If, however, the cambium layer has not been destroyed, and has been so covered by wax and bandages as to prevent evaporation and drying of the surface of the decorticated part, there is a chance for some of them to live. It is true that some few cases are recorded of trees which have lived several years after the bark and cambium layer have been removed, but they are of very doubtful authority.

M. Ernest Faivre, a French physiologist, gives a statement of his recent investigations on this subject, published in the "Gardener's Chronicle," about two months ago, in which he says: "In mulberry-trees, as in all trees deprived of latex, annular incisions generally produce the following manifestations: 1. Formation of a swelling, or tissue restorer, at the upper lip of the wound. 2. Diametrical growth of the parts above the zone of bark taken off. 3. Hardening of the wood in that region. 4. Stationary condition of the parts below, if they are deprived of leaves and buds; or, if not, vigorous shoots from below the lower lip of wound. 5. More easy, more early, and more abundant flowering and fructification. 6. Destruction, after a variable time, of all the parts above the annulation."

THE CIRCULATION OF THE CULEX.

Mr. H. C. Perkins gives an interesting paper in the "Monthly Microscopical Journal," for September. He says that, while watching the circulation as seen through the lenses in the reflected sunlight, if he moves the diaphragm from left to right, so as to make the shadow enter upon the right of the field of view, a brisk circulation (no matter how quiet it had been before) is instantly witnessed, which appears to be changed in direction as the diaphragm is moved back again; and that the direction of the circulation can thus be changed at will by the interception of the sunlight. This same result can also be witnessed by the passage of clouds between the sun and mirror. The actual direction in the plant is from the apex of the leaf in sunlight, and toward it in the shade. This change in direction is so rapid when produced by the shadow of fast-flitting clouds across the sun's disc that it would seem that the change of temperature could hardly be felt by the plant; it certainly could not be by an ordinary thermometer; but a heated body, properly placed, will quicken the circulation, as cold will retard it. If he mistakes not, we have here a fine demonstration of the conversion of light into heat by its passage through the vegetable tissues, and of heat into motion by its action upon the laticiferous vessel. — *Science Review.*

AN INTOXICATING FUNGUS.

It would seem, from a paper published by Dr. A. Kellog, that this fungus is more extensively used than we are aware of. The desired effect comes on from one to two hours after taking the fungus. Giddiness and drunkenness follow in the same manner as from wine or spirituous liquors; cheerfulness is first produced, the face becomes flushed, involuntary words and actions follow, and sometimes loss of consciousness. Some persons it renders remarkably active, proving highly stimulant to muscular exertion; but by too large a dose violent spasmodic effects are produced. So exciting is it to the nervous system of many that its effects are very ludicrous; a talkative person cannot keep silence or secrets; one fond of music is perpetually singing; and if a person under its influence wishes to step over a straw or a stick, he takes a stride or jump sufficient to clear the trunk of a tree. It is needless to say delirium, coma, and death often result, as in the case of alcoholic spirits. The most remarkable fact is that the fluids of the debauchee become singularly narcotic, and are therefore preserved in times of scarcity. Thus a whole village, as some say, may be intoxicated through the medium of one man, and this one fungus serves to prolong these most fearful and disgusting orgies for many days together. It is worthy of note that the very same erroneous impression as to size and distance produced by this plant, are also created by the hasheesh of India, and are also frequently noticed among idiots and lunatics. — *Science Review.*

IMPORTED INSECTS AND NATIVE AMERICAN INSECTS.

If we examine into the history of the imported currant-worm and the native currant-worm, we shall find a very curious state of things. These two insects both produce saw-flies, which are so closely allied to each other, that, although they are referred to distinct genera by entomologists, it may be doubted whether the genus (*Pristiphora*) under which the native species is classified be not a mere sub-genus of that under which the imported species is classified. Reasoning *à priori*, therefore, we should expect to find a very great similarity in the destructive powers of these two worms, especially as each of them infests the leaves both of the red currant and of the gooseberry. But what are the actual facts? On the one hand we see a native American species, which must have existed here from time immemorial, feeding on our wild gooseberries and perhaps on our wild red currant, and which yet has troubled our tame gooseberries and tame red currants so very slightly that it cannot be proved with absolute certainty to have ever done so at all, except in Rock Island County, Ill., and in Scott County, Iowa.

On the other hand, we see a species, only introduced into this country from Europe some 12 years ago, which has already almost put a stop to the cultivation of the gooseberry and red currant throughout a large part of the State of New York, the northern borders of Pennsylvania, and the whole of Canada West, and is slowly but surely extending itself in all directions from the point where it was originally imported. What can be the reason of such a wide difference in the noxious powers of two such closely allied insects, feeding on exactly the same plants, but one of them indigenous to America and the other imported into America from Europe? Nor is this the only case of the kind. We can point out at least three other such cases. The imported onion-fly (*Anthomyia ceparum*) is a terrible pest to the onion-grower in the East, though it has not yet made its way out West. On the other hand, the native American onion-fly (*Ortalis arcuata*, Walker), which is a closely allied species and has almost exactly the same habits, has only been heard of in one or two circumscribed localities in the West, and even there does comparatively but little damage. Again, the imported oyster-shell bark-louse (*Aspidiotus conchiformis*) is a far worse foe to the apple and certain other fruit-trees than our indigenous Harris' bark-louse (*Asp. Harrisii*), though each of them infests the same species. Finally, the imported meal-worm beetle (*Tenebrio molitor*) swarms throughout the whole United States, and is a great pest; while the native American species (*Tenebrio obscurus*), which has almost exactly the same habits, belongs to the same genus, and is of very nearly the same size, shape, and color, is comparatively quite rare among us, and is scarcely known to our millers and flour-dealers.

On a careful and close examination, it will be found that almost all our worst insect foes have been imported among us from the other side of the Atlantic. The Hessian fly was imported almost 90 years ago; the wheat midge about half as long ago; the bee moth at the beginning of the present century; the codling moth, the cabbage tinea, the borer of the red currant, the oyster-shell bark-louse, the grain plant-louse, the cabbage plant-louse, the currant plant-louse, the apple-tree plant-louse, the pear-tree flea-louse, the cheese-maggot, the common meal-worm, the grain-weevil, the house-fly, the leaf-beetle of the elm, the cockroach, the croton bug, and the different carpet, clothes, and fur moths, at periods which cannot be definitely fixed. Even within the last few years the asparagus beetle has become naturalized in New York and New Jersey, whence it will no doubt spread gradually westward through the whole United States, while the rape butterfly was introduced about a dozen years ago, and is rapidly spreading over some of the Eastern States. And only a year ago the larva of a certain owlet-moth (*Hypogymna dispar*), which is a great pest in Europe, both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England, where it is spreading with great rapidity. It is just the same thing with plants as with insects. We have looked carefully through Gray's "Manual of Botany," and we find that—excluding from consideration all cryptograms, and all doubtful cases, and all cases where the same plant is supposed to be indigenous on both sides of the Atlantic — no less than 233 distinct species of plants have been imported among us from the Old World, all of which have now run wild here, and many of which are the worst and most pernicious weeds that we have to contend against. In the United States "Agricultural Report" for 1865 (pp. 510–519) will be found a list of 99 of the principal "Weeds of American Agriculture," by the late Dr. Wm. Darlington. Of this whole number no less than 43, or nearly one-half, are species that have been introduced among us from the Old World. Among these we may enumerate here, as the best known and the most pernicious, butter-cups (two species), shepherd's purse, St. John's wort, cow-cockle, May-weed or dog-fennel, ox-eye daisy, common thistle, Canada thistle, burdock, plantain, mullein, toad-flax, bindweed, Jamestown (Jimson) weed, lamb's quarter, smart-weed, field garlic, fox-tail, grass, and the notorious cheat or chess. And to these we may add the common purslane, which, through some strange oversight, has been omitted in Dr. Darlington's catalogue.

It will be supposed, perhaps, since there are about as many voyages made from America to Europe as from Europe to America, that we have fully reciprocated to our transatlantic brethren the favors which they have conferred upon us, in the way of noxious insects and noxious weeds. It is no such thing. There are but very few American insects that have become naturalized in Europe, and even these do not appear for the most part to do any serious amount of damage there. For example, on one or two occasions single specimens of our army-worm moth (*Leucania unipuncta*) have been captured in England; but the insect has never spread and become ruinously common there, as it continually, in particular seasons, does in America. Our destructive pea-bug (*Bruchus pisi*) has also found its way to Europe; but although it is met with in England, and according to Curtis has become naturalized in the warmer departments of France, Kirby and Spence expressly state that it does not occur in England "to any very injurious extent," and Curtis seems to doubt the fact of its being naturalized in England at all. Again, the only species of white ant that exists within the limits of the United States (*Termes frontalis*) has been known for a long time to be the guest at the plant-houses of Schönbrunn, in Germany, but is not recorded to have ever as yet spread into the surrounding country. As to our American meal-worm (*Tenebrio obscurus*), Curtis states that it has been introduced into England along with American flour, and that it is sometimes abundant in London and the provinces; but Kirby and Spence say not one word about it, and it seems to be confined to the English sea-ports, and the places where American flour is stored, without spreading into the adjacent districts.

A very minute yellow ant, however (*Myrmica molesta*), which is often very troublesome with us in houses, has, according to Frederick Smith, "become generally distributed and naturalized" *in houses* in England; and Kirby and Spence state more specifically, that "it has become a great pest in many houses in Brighton, London, and Liverpool, in some cases to so great an extent as to cause the occupants to leave them." As to our chinch-bug, our curculio, our plum-gouger, our two principal apple-tree borers, our canker-worm, our apple-tree tent-caterpillar, our fall web-worm, our peach-tree borer, and our other indigenous pests among the great army of bad bugs, nobody ever yet found a single one of them alive and kicking on the other side of the Atlantic. And with regard to plants, the only two American plants that we know to have become so firmly established in Europe as to be a nuisance there, are an American aquatic plant, the common water-weed (*Anacharsis canadensis*), which has choked up many of the canals in England, and our common horse-weed, or mare's tail as it is called in the West (*Erigeron canadense*), which has spread from America nearly over the whole world. — *From the Report of Charles V. Riley, State Entomologist of Missouri.*

ATMOSPHERIC OZONE.

From the proceedings of the Institute of Lombardy, reported in the "Imparziale" of the 16th May, we extract the following results of the important experimental researches of Professor Mantegazza on the action of the essences of flowers on the production of atmospheric ozone. 1. The essences of mint, turpentine, cloves, lavender, bergamot, anise, juniper, lemon, fennel, nutmegs, cajeput, thyme, cherry, laurel, in contact with atmospheric oxygen in light, develop a very large quantity of ozone, equal if not superior in amount to that produced by phosphorus, by electricity, and by the decomposition of permanganate of potash.

2. The oxidation of these essences is one of the most convenient means of producing ozone, since even when in very minute quantity they can ozonize a large quantity of oxygen, whilst their action is very persistent.

3. In the greater number of cases the essences, in order to develop ozone, require the direct rays of the sun; in a small number of cases they effect the change with diffused light; in few or none, in darkness.

4. In some cases, however, the action just commenced in solar light was found to persist to some extent when the essence was placed in darkness.

5. In some cases a vessel perfumed with an essence, and afterwards thoroughly washed with alcohol and perfectly dried, could still develop a proportionate quantity of ozone, provided that it retained a slight odor of the essence.

6. The essences that developed the largest quantity of ozone were those of cherry, laurel, palmaroza, cloves, lavender, mint, juniper, lemons, fennel, and bergamot; those that gave it in less quantity were anise, nutmeg, cajeput, and thyme.

7. Camphor, as an ozonogenic agent, is inferior to all the above-named essences.

8. Eau de Cologne, honey-water, and other perfumes, or aromatic tinctures, develop a proportionate quantity of ozone when they are *exposed to the* direct rays of the sun.

9. The flowers of the narcissus, hyacinth, mignonette, heliotrope, lily of the valley, etc., develop ozone in closed vessels. Flowers destitute of perfume do not develop it, and those which have but slight perfume develop it only in small quantities. As a corollary from these facts the professor recommended the use of flowers in marshy districts and in places infected with animal emanations, as the powerful oxidizing influence of ozone may destroy them. The inhabitants of such regions should surround their houses with beds of the most odorous flowers. — *Nature.*

A NEW THEORY OF SLEEP.

Dr. E. Sommer has contributed to the "Zeitschrift für Rationelle Medicin" for 1869, a paper in which he promulgates the doctrine that sleep is nothing else than the result of a *deoxygenation* of the organism. According to this theory, the blood and the tissues possess the property of storing up the oxygen inhaled, and then supplying it in proportion to the requirements of the economy. When this store of oxygen is exhausted, or even becomes too small, it no longer suffices to sustain the vital activity of the organs, the brain, nervous system, muscles, etc., and the body falls into that particular state which we call sleep. During the continuance of this deep repose fresh quantities of oxygen are being stored up in the blood, to act as a supply to the awakened vital powers. Rest produces, though in a less degree, the same effect as sleep in reducing the expenditure of oxygen.

THE NEW AUSTRALIAN MUD-FISH.

The general form of *Ceratodus forsteri*, and its striking resemblance to *Lepidosiren*, will at once be seen by the accompanying figure (omitted). The length of the specimen described (which at the time the paper was written was the only individual yet obtained), was about 3 feet; it has a broad flat head, small eyes, and 4 limbs in the shape of flappers. The body is stated to be covered with large cycloid scales, 10 rows on each side. A large gill, opening in front of the pectoral limb, contains well-developed bronchiæ; but their accurate examination was not possible, on account of the bad condition of the specimen. A rather large pair of nostrils, situated just below the upper lip, communicates by a short tube with the roof of the mouth. The skeleton of this fish is partly ossified and partly cartilaginous, the vertebræ being pure cartilage, and the ribs hollow tubes, filled with cartilaginous substance. The palate and upper part of the skull are bony, and the head is covered by 2 large scales. The tongue is very small, and is attached to what appears to be a large hyoid bone, ossified externally. The rays which support the dorsal and caudal fin consist of hollow tubes filled by cartilage. In the upper jaw are two large teeth, which Mr. Krefft terms incisors, and which are obviously the representatives of the peculiar teeth in the corresponding position in *Lepidosiren*. Behind these are dental plates, divided on each side into 6 tooth-like projections. The lower jaw is provided with similar dental plates, but has no teeth in front; the rami are joined only by a tough skin. It is said to have flesh of the color of salmon, and to be excellent eating, so that the settlers have named it the "Burnett" or "Dawson salmon," from the two Queensland rivers in which it is principally found. The native name is given by Mr. Krefft as *Baramoonda* or *Baramoondi.* The fish is stated to attain sometimes a length of 6 feet and upwards. Mr. Krefft has referred the fish to the genus *Ceratodus,* — a name established by Agassiz in his "Poissons Fossiles" for the indication of certain teeth which were then supposed to be those of some kind of shark. Dr. Günther, our best living authority on the class of fishes, is, I believe, of opinion that, so far as the structure of *Ceratodus* is known, there is nothing to show that Mr. Krefft's decision is wrong, though it would appear to me to have been better to have proposed a new generic name for this animal. — *Nature.*

COMPARISON OF THE BRAINS OF MAN AND THE MAN-APES.

The collections of Dr. J. B. Davis and Dr. Morton give the following as the average internal capacity of the cranium in the chief races: Teutonic family, 94 cubic inches; Esquimaux, 91 cubic inches; Negroes, 85 cubic inches; Australians and Tasmanians, 82 cubic inches; Bushmen, 77 cubic inches. These last numbers, however, are deduced from comparatively few specimens, and may be below the average, just as a small number of Finns and Cossacks give 98 cubic inches, or considerably more than that of the German races. It is evident, therefore, that the absolute bulk of the brain is not necessarily much less in savage than in civilized man, for Esquimaux skulls are known with a capacity of 113 inches, or hardly less than the largest among Europeans. While the largest Teutonic skull in Dr. Davis's collection is 112.4 cubic inches, there is an Araucanian of 115.5, an Esquimaux of 113.1, a Marquesan of 110.6, a Negro of 105.8, and even an Australian of 104.5 cubic inches. But what is still more extraordinary, the few remains yet known of pre-historic man do not indicate any material diminution in the size of the brain-case. A Swiss skull of the stone age, found in the lake dwelling of Meilen, corresponded exactly to that of a Swiss youth of the present day. The celebrated Neanderthal skull had a larger circumference than the average, and its capacity, indicating actual mass of brain, is estimated to have been not less than 75 cubic inches, or nearly the average of existing Australian crania. The Engis skull, perhaps the oldest known, and which, according to Sir John Lubbock, "there seems no doubt was really contemporary with the mammoth and the cave bear," is yet, according to Professor Huxley, "a fair average skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage." Of the cave men of Les Eyzies, who were undoubtedly contemporary with the reindeer in south of France, Professor Paul

Broca says (in a paper read before the Congress of Pre-historic Archæology, in 1868): "The great capacity of the brain, the development of the frontal region, the fine elliptical form of the anterior part of the profile of the skull, are incontestable characteristics of superiority, such as we are accustomed to meet with in civilized races." We cannot fail to be struck with the apparent anomaly that many of the lowest savages should have as much brains as average Europeans. The idea is suggested of a surplusage of power; of an instrument beyond the need of its possessor. In order to discover if there is any foundation for this notion, let us compare the brain of man with that of animals. The adult male orang-outang is quite as bulky as a small-sized man, while the gorilla is considerably above the average size of man as estimated by bulk and weight; yet the former has a brain of only 28 cubic inches, the latter one of 30, or, in the largest specimen yet known, of 34½ cubic inches. "We see, then, that whether we compare the savage with the higher developments of man, or with the brutes around him, we are alike driven to the conclusion that in his large and well-developed brain he possesses an organ quite disproportionate to his actual requirements,—an organ that seems prepared in advance, only to be fully utilized as he progresses in civilization. A brain slightly larger than that of the gorilla would, according to the evidence before us, fully have sufficed for the limited mental development of the savage; and we must therefore admit, that the large brain he actually possesses could never have been solely developed by any of those laws of evolution, whose essence is, that they lead to a degree of organization exactly proportionate to the wants of each species, never beyond those wants; that no preparation can be made for the future development of the race; that one part of the body can never increase in size or complexity, except in strict co-ordination to the pressing wants of the whole. The brain of pre-historic and of savage man seems to me to prove the existence of some power distinct from that which has guided the development of the lower animals through their ever-varying forms of being.—*Amer. Jour. of Science and Arts.*

SOME ELEMENTARY PRINCIPLES IN ANIMAL MECHANICS.

The following is an abstract of a paper "On the Difference between a Hand and a Foot, as shown by their Flexor Tendons." By the Rev. Samuel Haughton, M.D., Dublin, D.C.L., Oxon, Fellow of Trinity College, Dublin. The fore feet of vertebrate animals are often used merely as organs of locomotion, like the hind feet; and in the higher mammals they are more or less "cephalized," or appropriated as hands to the use of the brain. The proper use of the hand when thus specialized in its action is to grasp objects; while the proper use of a foot is to propel the animal forward by the intervention of the ground. In the case of the hand, the flexor muscles of the fore-arm act upon the finger-*tendons,* in a direction from the muscles towards the tendons, which latter undergo friction at the wrist and other joints of the hand, the force being applied by the muscles to the tendon above the wrist, and the resistance being applied at the extremities of the tendons below the wrist by the object grasped by the hand. From the principle of "Least Action in Nature," we are entitled to assume the strength of each portion of a tendon to be proportional to the force it is required to transmit; and since, in a proper hand, these forces are continually diminished by friction, as we proceed from the muscle to the fingers, we should expect the strength of the tendon above the wrist to be greater than the united strength of all the finger-tendons. Conversely, in a proper foot, the force is applied by the ground to the extremities of the tendons of the toes, and transmitted to the flexor muscles of the leg, by means of the tendons of the inner ankles, which undergo friction in passing round that and the other joints of the foot. In this case, therefore, we should expect the united strengths of the flexor tendons of the toes to exceed the strength of the flexor tendons above the heel. In the case of the hand, friction acts against the muscles; in the case of the foot, friction aids the muscles. I have measured the relative strengths of the deep flexor tendons of the hand above and below the wrist in several animals, and also the relative strengths of the long flexor tendons of the foot above and below the ankle, in the following manner: I weighed certain lengths of the tendons above the wrist and ankle, and compared these weights with the weights of equal lengths of the flexor tendons of the fingers or toes, assuming that the weights of equal lengths are proportional to their cross sections, and these again proportional to the strengths of the tendons at the place of section. The difference between the weights above and below the joint represents the sum of all the frictions experienced by the tendons between the two points of section. Tables are given showing the results of measurements, for example, in the case of the Pyrenean mastiff the amount of friction is 65.4 per cent., while in the Boomer kangaroo it is *nil*. The foregoing animals all realize the typical idea of a true foot, with a variable amount of friction at the ankle-joint; this friction disappearing altogether in the Boomer kangaroo, whose method of progression realizes absolute mechanical perfection, as no force whatever is consumed by the friction of the flexor tendons at the heel. The only animals whose feet deviated from the typical foot were 3, namely, the alligator, common porcupine, and phalanger. In these animals the foot has the mechanical action of a hand, or grasping organ; and the flexor tendons above the ankle exceeded those below the ankle by the following amount: Alligator, 11.5 per cent.; common porcupine, 20.0; phalanger, 29.2. In the case of the flexor tendons of the hand, results were obtained varying from 71.0 in the case of the common porcupine, to *nil* in the case of the goat. It will be observed that the fore foot of the goat, regarded simply as an organ of locomotion, attains a perfection comparable with that of the hind foot of the kangaroo, no force being lost by friction at the wrist-joint. The only animal in which I found a departure from the typical hand was the llama, in which the flexor tendons of the fingers exceed the flexor tendons above the wrist by 14.4 per cent. The bearing of the foregoing results in the habits of locomotion of the several animals will suggest themselves at once to naturalists who have carefully studied those habits. I shall merely add that the subject admits of being carried into the details of the separate or combined actions of the several fingers and toes, and that the habits of various kinds of monkeys in the use of certain combinations of fingers or toes may be explained satisfactorily by the minute study of the arrangement and several strengths of the various flexor tendons distributed to the fingers or toes. — *Nature.*

THE VOLCANO FISH.

A paper having appeared some time since in a contemporary, from the pen of the Rev. W. W. Spicer, in which the phenomenon of the expulsion of fish from volcanoes was spoken of as strange and astounding, and the idea being conveyed that the fish must have "lived in the line of fire" before being expelled, Mr. Scrope, F.R.S., writes to "Scientific Opinion," February 23, as follows: "This sensational version of a very simple fact is one only of several which, on the authority of 'the great Prussian traveller,' have been repeated by compilers of treatises on volcanic phenomena. The simple fact, I conceive, is that the fish in question lived in the open air in crater lakes, such as are frequently found at the summit of trachytic volcanoes, — for the reason that the fine ash, which is usually the last product of their eruptions, and therefore forms the lining of their craters, is very retentive of moisture, and consequently occasions the production of lakes at the bottoms of these hollows. Of course, in these lakes the same kind of fish will probably be found as, by Mr. Spicer's own statement, are met with in other lakes at an almost equal elevation on the outer sides of these very volcanoes."

CHANGES IN FISHES.

In the "American Naturalist," Charles C. Abbott, M.D., gives some account of the changes in the fishes of New Jersey within a few years. A slight local disturbance sometimes quite alters the fauna. Thus, in 1867, a small, never-failing brook, emptying into the Assumpink, was populated by chubs, dace, and minnows. In July a heavy, sudden fall of rain caused a rise of water, but did not alter the brook enough to attract the attention of those who lived near it. After the subsidence of the water not one of these fish could be found there, while their place was taken by roach, mullets, and red-fins, which are now abundant, while not a chub can be found.

Dr. Abbott mentions several fishes that were not inhabitants of the New Jersey streams 25 years ago, which are now quite abundant; and he is greatly at a loss to imagine how they can have reached these streams. He mentions the interesting case of the gizzard *shad, which* is sometimes carried by freshets into inland streams or ponds. A pond near Trenton was stocked with them in 1857, and is now full of specimens, weighing sometimes 5 pounds. They have become so different in color from the same fish as found in the Delaware and on the coast, that Dr. Abbott at first thought them quite distinct; and he says they have changed considerably, but only in color, during the last 10 years.

PHYSIOLOGY OF FATS.

The new number of the "Zeitschrift für Biologie" (VI. i.) contains an interesting paper by Subbotin "On the Physiology of Fats." Towards an answer to the question, Is there in the animal organism any direct passage of fat from the alimentary canal to the cells of adipose tissue?—a lean dog was fed for a month on meat, spermaceti, and common fat. Of the 1,000 grms. of spermaceti swallowed, 800, at least, were absorbed; but the merest trace only of spermaceti could be found in the fatty tissue of the body at the close of the experiment. Spermaceti, therefore, though absorbed and consumed in the economy, is not stored up unchanged. Hence there is a presumption that the same is the case with other fats (though it is obvious that many possible events might negative the presumption). Towards solving the further question, Are fats formed in the body out of proteids?—a dog reduced to the utmost leanness was fed on leanest meat and palm oil (palmitin and olein), for 25 days, during which he gained 3 kilos in weight. The fat of the body was, at the close, found to contain 13.9 per cent. of stearin. Though none had been taken, a very considerable quantity of stearin had therefore been formed in the body. A very lean dog was fed for 6 weeks on leanest meat, and a soda soap made with palmitic and stearic acids only. At the end of the experiment, the dog having gained over 3 kilos in weight, the fat of the body was found to consist of 53.6 per cent. palmitin, 13.4 per cent. stearin, and 33 per cent. olein. A large quantity of olein had therefore been formed in this case. But if olein was thus formed, possibly the palmitin and stearin were likewise formed from proteids, and not by synthesis of the fatty acids with the glycerine of the economy. Subbotin further points out that olein is more abundant in the subcutaneous than in the deep-seated fat; possibly on account of a less energetic transformation of proteids in the cooler surface regions; so also in cold-blooded animals the fat is proportionally richer in olein.—*Nature.*

AGUE POISON.

M. P. Bolestra has communicated to the French Academy some observations on ague poison. He says, that in examining marsh water he always finds, in proportion to its degree of putrefaction, a granular microphyte, somewhat resembling in form the *Cactus Peruvianus*. It is always accompanied by a considerable quantity of small spores, one-thousandth of a millimeter in diameter, greenish-yellow and transparent, and also by sporangia or vesicles containing spores from two one-hundredths to two three-hundredths of a millimeter in diameter, and of a very characteristic form. This plant grows on the surface of the water; when young, it is rainbow-like in tints, and looks like spots of oil. At the low temperature of cellars and in water containing no vegetation, it develops slowly, but in contact with air and exposed to solar rays, it grows fast, disengaging small gas-bubbles. A few drops of arsenious acid, sulphite of soda, or, still better, neutral sulphate of quinine, stops its vegetation at the surface of the water, the spores become thin and transparent, and the sporangia alter so that they would not be recognized. These changes may be seen under the microscope. M. Bolestra states that these spores can be found in marsh air. He caught agues twice during his researches, — once after having been exposed to air from water in fermentation covered with fresh algæ in full vegetation, mixed with an extraordinary quantity of spores. He thinks these spores constitute the ague poison.

SNAKE POISON.

Professor Halford, of the University of Melbourne, in a paper read before the Medical Society of Victoria, has reviewed at length the history of 20 cases of snake-bite treated by his method of injecting liquor ammoniæ into the veins during the last 18 months. These cases were all in the hands of different practitioners in the colony, who have each reported on them. Recovery followed in 17 cases. In 13 of these the practitioners in attendance expressly report that the patients were in a dying condition, and, in their belief, would soon have died but for the employment of this remedy in the manner prescribed. The method employed was that introduced by Dr. Halford, and first brought to the knowledge of the profession here by him, in the pages of the "British Medical Journal," through Mr. Paget; namely, by injecting dilute ammonia, say, at the least, 30 minims of the liquor ammoniæ B. P., specific gravity 959, into a superficial vein; the vein being first exposed, and its coats pierced with the nozzle of a hypodermic syringe. Dr. Dempster, Dr. Rae, Dr. Langford, Mr. Dallimore, and Dr. Meyler, each in his own words, and from the observation of separate cases, describe the effect as being immediate, and the recovery from collapse to be so rapid and startling as to be almost "magical." This method of treatment, of which such remarkable effects are detailed, has been sharply criticised; but Professor Halford successfully vindicates the claim of the snakes to be considered highly venomous, — almost as much so, he intimates, as some of his London critics. They included the tiger-snake, the brown and black snake of Australia, which are affirmed to be as deadly as the cobra and rattlesnake of India. Strong testimony to the efficacy of the treatment in saving life was borne by Australian practitioners who took part in the discussion, and vindicated Professor Halford's claim to be considered as the discoverer of a means of rescuing many from an otherwise *inevitable* death. — *Nature.*

PREPARATION OF BIRDS AND SMALL ANIMALS FOR THE CABINET.

H. W. Parker communicates to the "American Journal of Science and Arts" the following, upon the use of carbolic acid in the preparation of cabinet specimens: —

"The following methods, carefully studied for two years, with results noted, are recommended for the saving of birds in warm weather until the operator finds time to skin them; for the permanent preparation of drawer specimens, where the student needs a large series of individuals to determine the variations and limits of species; and for mounting small birds, at least as temporary representatives, when neither the time nor the expense involved in the old methods can be afforded.

"The viscera are removed, to effect which neatly the legs are pinned widely apart, and a paper several times folded is pinned over the tail in the direction whither the viscera are drawn out. With proper care, the sex is readily observed. A wad of cotton absorbs the fluids remaining in the cavity. The leg is then grasped close to the body, and a knife or wire is introduced into the cavity and run down into the flesh of the leg, working the instrument around, but not so as to break the skin. For a small bird, 5 to 10 drops of the commercial fluid preparation of carbolic acid is made to anoint the whole interior, and to penetrate the leg by stretching and relaxing the same in proper position. The application is repeated after the first drops are absorbed; and a wad of cotton, wet with the acid, may be left close under the breastbone next to the neck. The cavity is then filled with cotton and the skin drawn back into place. The inside of the mouth is well anointed, and a saturated wad of cotton pushed down the whole length of the neck. The eyes are removed by a hooked wire inserted into the ball, the head being so held that the humors of the eye will drop without soiling the lids. The moist lids are left as open as possible, and the specimen placed in a cool cellar to the next day, when the lids are dry enough to take their open shape. Then a nail is inserted through the lids and pushed through the bone at the back part of the orbit into the brain, and so worked as to make a good opening. A tightly rolled bit of cotton, saturated with the acid, is pushed into the brain and worked around in it, care being taken not to wet the eyelids. If by chance the feathers are wet, the acid can be removed by powdered chalk, repeatedly applied.

"Specimens so prepared in warm weather can be skinned a week or two after, if kept boxed in a cellar. No smell of decomposition is observed; the acid gradually and completely penetrates the pectoral muscles; the skin is strong and the feathers not loosened.

"For permanent preparation, the skin should be laid open from the abdomen to the neck, the pectoral muscles removed and replaced by cotton, and the incision sewed up. The throat, neck, and orbits are also filled with cotton. The specimen should then be suitably arranged, encircled by a slip of paper, and placed on a bed of cotton. Before this, the flesh of the wings should be laid open and arsenic applied in the usual manner.

"For mounting it only needs to run one wire through the foot, tarsus, and so on through the neck to the forehead, and another wire through the other foot to any point in the back or breast where the end of the wire catches firmly. Papers or strings for keeping the feathers in place should remain long. Some shrinking about the head and neck will eventually follow in the case of many birds, particularly those of the smallest size, or of scanty or close plumage; but in other instances no shrinking whatever can be noticed after more than a year of drying. The cabinet in which they have been set up is made insect-proof by means of pasted cloth and paper, putty and paint, 15 inches passage-way being left in front of the shelves, and the only access being through a tight door at one end, fastened by a screw.

"Travellers, who desire to collect a large number of birds for comparison, will find this method one of great advantage; and the specimens will be better for study than skins, inasmuch as the proportions will be better preserved. Small mammals can be kept some days for skinning by a similar process, and an opening into the brain may be made through the roof of the mouth, if preferred. A fox squirrel, so treated, was in good condition for skinning after 4 days' preservation, in very warm weather. This, with similar methods of preparing specimens without skinning, has been found of little use in the damp air of the Eastern States."

ASTRONOMY AND METEOROLOGY.

NEW SPECTROSCOPE.

PROF. C. H. YOUNG, of Dartmouth College, thus describes in the "Journal of the Franklin Institute," a new form of spectroscope: "The instrument was designed for attachment to the equatorial of 6.4 inches aperture and 9 feet focal length, belonging to the observatory of Dartmouth College. It is specially intended for observations upon the solar spots and protuberances, and accordingly the principal object kept in view has been to combine a very high degree of power with compactness, lightness, facility of manipulation, and firmness of construction. Having the dispersive power of 13 prisms of heavy flint, each with an angle of 55°, it yet weighs less than 15 pounds, and measures over all 15 inches in length, 8 in breadth, and 4½ in height. It was made by Alvan Clark & Son.

"The collimator and observing telescope have each an aperture of seven-eighths of an inch, and a focal length of 7 inches, which might advantageously have been increased to 12 inches, were it not for the necessity of compactness.

"The light from the slit, after passing the collimator, is transmitted through the lower portion of a train of 6 prisms of heavy flint glass, each 2¼ inches high, and having, as stated above, a refracting angle of 55°. A seventh *half-prism* follows, and to the back of this is cemented a right-angled prism, by which, after 2 total reflections, the light is sent back through the upper part of the same train of prisms, until it reaches the observing-telescope. This is placed directly above the collimator, and firmly attached to it. Finally, a diagonal eye-piece brings the rays to the eye in a convenient position for observation.

"The instrument thus has the dispersive power of 13 prisms, and even with the low magnifying power of only 5 on the observing-telescope, shows perfectly the lines of aqueous vapor which make their appearance between the sodium lines when the sun is near the horizon. Of course, everything shown on the maps of Kirchhoff and Angstrom is readily seen with it, and many lines besides.

"Its definition is very beautiful, and the only optical fault of the instrument seems to be a curvature of the lines, resulting from the shortness of the collimator.

"After planning the instrument, I learned that the same idea of sending the light twice through the prisms by a right-angled prism at the *end of the* train had also occurred to Mr. Lockyer and others; but I do not know that it has yet been put in practice elsewhere.

"The prisms, for protection and convenience of handling, are set in frames of blackened brass. They are arranged around the circumference of a hollow cylinder of elastic gun metal, 3½ inches in diameter, with stout flanges above and below, between which they are clamped by little thumb-screws, so that they can be readily removed or transposed; it requires less than a minute to put the last prism with its reflector in place of any other of the train, thus reducing the dispersive power to any extent desired.

"No particular care is required in placing the prisms, as a couple of narrow flanges were cast upon the cylinder near the top and bottom, and afterwards planed off to form true bearings for the backs of the prisms. They are thus always correctly set by being simply slid home before tightening the clamping screws.

"The lower flange of the cylinder is attached to the base-plate by a screw directly under the middle of the front face of the first prism. Around this point, as a centre, the whole system of prisms is movable by means of a double-threaded tangent-screw, which brings the different portions of the spectrum into the field of view.

"The adjustment of the prisms to their angle of minimum deviation is effected by a method devised by Mr. George Clark, which is exceedingly simple, and, if not theoretically exact, answers every practical purpose. The flanges between which the prisms are clamped are sawed through between the prisms, and a portion of the cylinder, flanges and all, equal to an arc of about 30°, is cut out between the first prism and the last. On closing up or spreading open this gap by means of a suitable tangent-screw, the circumference of the circles around which the prisms stand is correspondingly enlarged or diminished. Probably, when the ends of this opening are drawn very near together, or spread very far apart, the cylinder is somewhat distorted, and a corresponding mal-adjustment of the prisms results; but if so, the effect is very slight.

"The instrument gives a perfect view of every part of the spectrum from below A to H; above *h*, however, when all 7 prisms are used, there is a loss of light occasioned by a partial obstruction of the apertures of the collimator and telescope by the corner of the reflecting prism.

"Were it important to secure the perfect cylindricity of the prism-frame through the whole range of adjustment, it could be easily done by merely fastening at the back of each prism a radial bar acting upon a central pin, as in the arrangement first devised by Mr. Rutherfurd, and since adopted by Mr. Browning, in his automatic spectroscope.

"This plan of Mr. Clark's, doing away with all joints and hinges, has the great advantage of perfect firmness and solidity in every position of the instrument, — an advantage hardly to be overrated in an astronomical spectroscope.

"Had it occurred to me in season I might have made the instrument still simpler, firmer, and perfectly automatic in its adjustment, by merely substituting for the first prism a *half prism*, like the last of the train, to which the right-angled reflecting prism is cemented.

"Placing this first *half prism* with its front face perpendicular to the line of collimation, it would never need to be disturbed; the flange of the cylindrical frame which carries the prisms would be firmly fastened to the bed-plate immediately beneath it, and the pivot joint at this place with the corresponding tangent-screw would be dispensed with. The only adjustment required would be that produced by the screw which is now used to adjust for minimum deviation by opening or closing the gap of the cylinder.

"Of course, this arrangement would reduce the dispersive power of the train by the amount of one prism, a loss easily made up by adding a degree or two to their refracting angles.

"It might be better to place the face of the first prism not exactly normal to the line of collimation, in order to avoid repeated reflections between it and the object-glass of the collimator, which would be likely to produce a troublesome ghost, or the same thing might be accomplished by simply cementing the object-glasses of both collimator and observing-telescope directly upon the front of the prism; this would make the instrument still more solid and compact.

"The eye-piece of the instrument has an apparatus attached, which, however, thanks to the high dispersive power, I find unnecessary.

"It was early proposed by Janssen to use a vibrating or rotating slit, in order to make visible the form of a solar prominence, but, as Zöllner has shown, the mere opening of the slit answers just as well, the light of the protuberance being diluted to precisely the same extent in either case.

"It occurred to me in connection with a suggestion of Professor Morton, that, by interposing at the focus of the eye-piece a diaphragm which should move with the vibrating slit, the light of the neighboring portions of the spectrum might be cut off and this dilution avoided. Mr. Clark has devised and constructed a very beautiful mechanical arrangement by which this simultaneous and accordant motion of slit and diaphragm is effected by the rotation of a small fly-wheel.

"But I find that, although seen in this way, the prominences appear very bright; yet the working of the apparatus always causes a slight oscillation of the equatorial, which interferes with the definition of details, and I prefer to work with the slit simply opened. When the air is free from haze, the whole extent of a prominence 30,000 miles in height is readily examined through the C or F line, and the most delicate details reveal themselves, with a beauty and clearness of definition which even yet always surprises me, and speaks most emphatically for the exquisite workmanship of the 43 different surfaces by which the light is either refracted or reflected on its way from the slit of the collimator to the eye.

"But, although I do not use the vibration of the slit and diaphragm, *I find the mobility* of the slit so convenient as to be practically indispensable. In examining the spectrum of a group of sun-spots, for instance, it is very much easier to move the slit to the particular point we wish to observe than to move the solar image by the tangent screws of the equatorial. The protuberances are so well seen through the F and 2796 (*near* G) lines, that it is even possible to photograph them, though, perhaps, not satisfactorily with so small a telescope as the one at my command. Some experiments I have recently made show that the time of exposure, with ordinary portrait collodion, must be nearly 4 minutes, in order to produce images of a size which would correspond to a picture of the solar disc about 2 inches in diameter. This length of exposure demands a more perfect clock-work than my instrument possesses, and a more accurate adjustment of the polar axis than it had during the experiments, as well as a steadier condition of the atmosphere.

"Thus far, therefore, I have not been able to produce anything which could properly be called a good picture. Negatives have been made which show clearly the presence and general form of protuberances, but the definition of details is unsatisfactory. This amount of success was reached upon September 28, when impressions were obtained of 2 protuberances on the S.E. limb of the sun, and, slight as this success was in itself, I consider it of importance in showing the perfect feasibility of going much further with more sensitive chemicals, more delicate adjustments, and greater telescope power. I was aided in the experiments by Mr. H. O. Bly, our local photographer, to whom are due my warmest acknowledgments for the interest, patience, ingenuity, and skill, with which he assisted me.

"We worked through the Hydrogen γ line (2796 of Kirchhoff's scale), which, though very faint to the eye, was found to be decidedly superior to F in actinic power. The photographic apparatus employed consisted merely of a wooden tube, about 6 inches long, attached at one end to the eye-piece of the spectroscope, and at the other carrying a light frame. In this frame was placed a small plate-holder, containing for a sensitive-plate an ordinary microscope slide, 3 inches by 1. The image of the prominence, seen through the open slit, is magnified and thrown upon this plate by the eye-piece."

PHOTOGRAPHING THE SUN.

At a meeting of the American Academy, May 24, 1870, Professor Joseph Winlock exhibited a photograph of the sun taken with a lens of 40 feet focus, and 4 inches aperture. As it is difficult to place a tube of this length in an inclined position, it is laid horizontally, and an image of the sun is reflected into it by a plane mirror of unsilvered glass. When this mirror was blackened on one side it became heated to such an extent as to shorten the focus of the lens nearly 3 feet. The image obtained is about 4 inches in diameter, and is free from distortion produced by an *eye-piece.* The exposure is instantaneous, and is effected by passing a diaphragm with a slit in it between the lens and the mirror. A better effect is thus obtained than by the usual method of placing it near the plate-holder. The lens, which was made by Messrs. Clark and Sons, is not achromatic, as its slight curvature rendered this unnecessary. It was corrected for spherical aberration by means of an artificial star, produced by a soda flame, and a collimator, of an aperture somewhat greater than that of the lens.

SPECTRUM OF THE SOLAR ATMOSPHERE.

M. Rayet, in a note to the "Comptes Rendus" of Aug. 1, 1870, shows that particular conditions are needed in order that vapors of iron in the atmosphere should only give 5 lines. He finds that it is possible to see 22 luminous lines of various substances in the spectrum of the solar atmosphere, and gives the wave-length of some lately observed lines.

SOLAR SPOTS.

M. R. Wolf, of Zürich, has just published the résumé of his observations on the solar spots made since 1864. The minimum occurs in 1867, and agrees with the period of 11 1-9 years, found by Sabine and himself. Designating the relative frequency of the spots by r, M. Wolf expresses the variations of the magnetic declination at Christiania by the formula $r = 0.0413'r + 4.921'$, which does not, however, completely agree with observation. — *Moniteur Scientifique.*

THE ROYAL ASTRONOMICAL SOCIETY.

March 11, Mr. Proctor read a paper entitled "Notes on the Corona and the Zodiacal Light," with suggestions respecting the modes of observation to be applied to the eclipse of next December. He remarked that if we have in reality sufficient evidence to determine whether the corona is or is not a solar appendage, it would be a misfortune, and in a sense discreditable, to science, were the short time at the disposal of observers wasted in futile observations directed to settle a point determinable beforehand. He then expressed his conviction that the corona cannot be a terrestrial phenomenon. He pointed out that the very blackness of the moon as compared with the corona showed that the coronal light is behind the moon. The moon is, in fact, projected on the corona as a background, he urged, whereas the theory that the light is due to atmospheric glare requires that the corona should be a foreground. But passing over this argument, which is liable to the fatal objection of being too simple, he proceeded to inquire whether air which lies between the observer and the corona is in reality illuminated. He showed that all round the sun, for a distance of many degrees, there should be perfect darkness if the illumination of the atmosphere by direct solar light were in question. As to the atmospheric glare due to the chromosphere and prominences, he argued that it must be relatively small, because it could bear no higher proportion to the actual light of the chromosphere than ordinary atmospheric glare bears to actual sunlight, and we know this proportion is very small indeed. Again, as to light reflected from the atmosphere outside the shadow-cone, or from the surface of the earth, he urged that that also must be small, since not any part of the atmosphere above the observer's horizon was illuminated by more than a half-sun, while all the parts near the shadow-cone were in nearly total shadow. But a fatal objection to the view that the corona could be due either to the glare from the prominences or to light reflected from the surrounding air, consisted in the fact that such glare ought to cover the moon's disc. He then referred to a number of observations confirming the view that the coronal light is not terrestrial; as the appearance of glare during partial eclipses, this glare always trending on the moon's disc; the relatively greater darkness of the central part of the moon's disc in annular eclipses; the visibility of that part of the moon's disc which lies beyond the sun in partial eclipses, the limb being seen dark on the background of the sky; the visibility of the corona in partial eclipses, even its most distinctive peculiarities having been recognized when the sun's disc is not wholly covered; and several other phenomena. He then adduced evidences to show that a solar appendage, which one would expect to appear during total eclipses, actually does exist. First, the zodiacal light shows that the sun is surrounded by such an appendage. Dr. Balfour Stewart's theory of this object, however physically sound, was opposed, he urged, by too many astronomical objections to be accepted for a moment. An object which exhibits no appreciable parallax, which rises and sets as the celestial objects do, and maintains a position in the heavens having a nearly constant relation to the ecliptic, cannot by any possibility be due to any peculiarity of the earth's atmosphere. Then Leverrier has shown that the motion of Mercury's perihelion indicates the presence of a ring of bodies in the sun's neighborhood; and Mr. Baxendall has drawn a similar conclusion from the meteorological records of well-known observatories. Lastly, judging of the meteor systems according to the laws of probability, we have every reason to believe that for each one our earth encounters there must be millions whose perihelia lie within the earth's orbit. Since the earth encounters 56 such systems, it will be seen how enormous must be the total number. These should be visible during total eclipses, and since they would shine in part by reflected light, and in part through their intrinsic light (for those which come as near the sun as some comets have been observed to do must be melted or even vaporized by the sun's heat), we have an explanation of the contradictory accounts given by those who have applied the polariscope and the spectroscope to the solar corona. Mr. Stone remarked that there ought to be 3 sets of observations made with the polariscope next December, since if there were but two the result would probably be contradictory, as was the case with regard to the observations made in India, in 1868, and in America last year. Different parts of the corona ought also to be examined. — *Nature.*

SOLAR PROTUBERANCES.

The following is a communication to the editor of the "Journal of the Franklin Institute" (Professor Morton) from Professor Young of Dartmouth College: —

"I write to inform you that last Thursday, Sept. 22d, about 11 A.M. Hanover mean time, I was so fortunate as to see the sodium lines D_1 and D_2 reversed in the spectrum of the umbra of a large spot near the eastern limb of the sun. At the same time the C. and F. lines were also reversed, but with the great dispersive power of my new spectroscope I see this so often in the solar spots, that it has ceased to be remarkable.

"I am not aware that this reversal of the sodium lines in a spot spectrum has ever been observed before; its reversal in the spectra of prominences is not very unusual. A small prominence on the western limb of the sun, which was visible the same forenoon, presented all the following bright lines, namely, C, D_1, D_2, D_3, 1474, b_1, b_2, b_4, 1989.5, 2001.5, 2031., F, 2581.5, 2796., and h; 15 in all.

"In the spot spectrum the magnesium lines b_1, b_2, and b_4, were not reversed, but while the shade which accompanies the lines was perceptibly widened, the central black line itself was thinned and lightened."

SPECTRUM OF A SOLAR PROMINENCE.

Professor Young, of America, has made a remarkable observation. On April 9, 1870, there was an exceedingly bright prominence on the south-west limb of the sun, near, but not over, a large spot which was passing off. At the base of this prominence, which was shaped like a double ostrich-plume, the C line was intensely brilliant, so that the slit could be opened to its whole width in studying the form of the prominence, but this line was not in the least distorted. On the other hand the F line, also very brilliant, was shattered all to pieces, so that at its base it was 3 or 4 times as wide as it ordinarily is, and several portions were entirely detached from the rest. This is a most perplexing result, and seems to throw doubt on the interpretation which has hitherto been given to the displacement of the solar spectral lines. As Professor Young remarks, "Since the C line was not similarly affected, it is hardly possible to attribute this breaking up of F to cyclonic motions in the gas from which the light emanates, and it becomes very difficult to imagine a cause that can thus disturb a single line of the spectrum itself." "Possibly," he adds, but we must admit we can hardly conceive the possibility, "the appearance may be the result of local absorptions acting upon a line greatly widened by increase of pressure or temperature." In other words, as we understand him, Professor Young would imply that the bright F line was really undistorted, though widened, while distorted absorption lines belonging to some other element produced the appearance of shattering. But apart from the difficulty of assuming cyclonic motions in this other element, around a relatively quiescent hydrogen-core, we know of no elements having lines close by F strong enough to produce the observed result. The apparent dissociation of the F and C lines is a phenomenon of a very perplexing character. — *Science Review.*

NEW OBSERVATORY IN THE SOUTHERN HEMISPHERE.

The following statement with regard to the Cordova Observatory, to the foundation of which we have before referred, is extracted from the last number of Silliman's "American Journal of Science and Arts:" —

"The Argentine Congress voted to establish a national observatory at Cordova, at the instance of President Sarmiento, and through the exertions of the present Minister of Public Instruction, Dr. Avelleneda, who invited me to organize and take charge of it, knowing my desire to extend the catalogue of the southern heavens beyond the limit of 30°, to which the zones of Argelander extend. Bessel went through the region from 45° N. to 15° S., with systematic zone observations at Königsberg, which have since been reduced and published in two catalogues by Weisse, of Cracow. Argelander carried the same systematic scrutiny with the Meridian Circle, from Bessel's northern limit to the pole, and afterwards from Bessel's southern limit to 30° S.

"Since then Gilliss has observed a series of zones for 30° around the south pole; but the reduction of these, although very far advanced, was not completed at the time of his death, and the manuscript is now stored somewhere in Washington. Let us hope that it may at some time be recovered, the work completed, and given to the world. My hope and aim is to begin a few degrees north of Argelander's southern limit, say at 26° or 27°, and to carry southward a system of zone observations to some declination beyond Gilliss's northern limit, thus rendering comparisons easy with both these other labors, and permitting the easy determination of the corrections needful for reducing positions of any one of the three series to corresponding ones for the other. It is of course impossible to arrange in advance the details of such an undertaking, but my expectation is to go over the region in question in zones 2° wide (except in the vicinity of the Milky Way, where the width would be but one-half as great), up to a declination of about 55°, after which the width would be gradually increased as the declinations became greater. Within these zones all stars seen as bright as the 9th magnitude would be observed, so far as possible, moving the telescope in altitude when no bright star is in the field until some one becomes visible, according to the well-known method of zone-observations. For reducing the observations, differential methods will probably be employed, inasmuch as the time now assigned for my absence from home would be inadequate for proper discussion of the correction required for nice determinations of an absolute character. Still, it is my present purpose, so far as possible, to make such subsidiary determinations as might hereafter be needed in any attempt at computing the observations absolutely. But as I hardly venture to anticipate any opportunity of making a thorough determination of the constants of refraction, or of the errors of graduation, it seems best to arrange for a differential computation at least at first. It is improbable that a sufficient number of well-determined stars will be found available even for this differential reduction, and the necessity may thus be entailed of determining the comparison-stars myself, this determination, however, itself depending upon standard star places. So far as possible I propose employing those heretofore determined by me, and published by the Coast Survey, which form the basis of the star places of the American 'Nautical Almanac.' With these observations of position it is my hope to combine others of a physical character to some extent; but in the presence of a plan implying so much labor and effort, it would be unwise to rely upon the possibility of accomplishing much more than the zone-work. The meteorological relations of the place are very peculiar; but I dare not undertake any connected series bearing upon these, without self-registering apparatus, which is beyond my means. Cordova is one of the oldest cities, and contains the oldest university, of the Western Hemisphere. It is situated in 31½° S. latitude, on the boundary of the Pampa, where the land begins to rise towards the group of mountains known as the Sierra de Cordova. It is connected with Rosario, on the Parana, by the Central Argentine Railway, which has probably been already opened to travel through its entire length of about 280 miles, although information to that effect has not yet reached this country The two largest instruments will be a Repsold meridian-circle of 54 inches' focal length, and 4½ inches' aperture, and an equatorial, by Alvan Clark and Sons, provided with the 11-inch object-glass, by Fitz, lately in the possession of W. Rutherfurd, who has supplied its place by one of 13 inches. A photometer, by Ansfeld, of Gotha, according to Zöllner's latest form, has been constructed under the supervision of Professor Zöllner himself; a spectroscope will be furnished by Merz, of Munich, and a clock by Tiede, of Berlin. The scientific institutions of the United States have afforded the expedition every possible assistance. The Coast Survey lends a circuit-breaking clock, a chronograph, and a portable transit; the Smithsonian Institute lends a zenith telescope; the American Academy of Arts and Sciences, of Boston (probably), a photometer and spectroscope; the Washington Observatory and the 'Nautical Almanac' have greatly aided the undertaking by gifts of books, and by a manuscript copy of Gilliss's 'Catalogues of Standard Stars;' and from the astronomers of England, Germany, and Russia, important assistance has been freely and effectively contributed, in the order and supervision of instruments and apparatus, and by the gift of books, as well as by important and valuable suggestions. Four assistants will accompany me, — Messrs. Miles Rock, John M. Thome, Clarence L. Hathaway, and William M. Davis, Jr. We hope to reach Buenos Ayres not later than the middle of August. The building is now under construction in Boston. The means available proved inadequate for its construction according to the original plan, which was in the form of a cross, with 4 square rooms about its centre, and turrets at its 4 extremities. One-half of it will be first erected, and it is hoped that the remaining portion will speedily be added." — *Nature.*

ARTIFICIAL HORIZON.

At the Troy meeting of the American Association, Mr. Hilgard exhibited a very ingenious arrangement of J. H. Lane, by which the vibration or ripple, which acts so annoyingly under many circumstances with the ordinary tank of mercury, is effectively suppressed.

It consists of a shallow dish, with a circular groove around its edge, and a cavity beneath, which communicates with the groove by a space, while by means of a tube air may be blown at will into the cavity. This cavity and the circular groove are filled with mercury. By blowing into the cavity, more mercury is raised and overflows into the central portion of the dish. On now allowing the air to escape and the excess of mercury to flow back into the cavity, a film, held by its cohesive force, is retained over the surface, and, by reason of its thinness, this is incapable of maintaining a vibratory or ripple movement. A touch with the finger will instantly break up this surface; but it is easily reformed, and experience has shown that it is not deflected from its horizontal direction by slight inclination of the dish.

THE NEW CAMBRIDGE TRANSIT INSTRUMENT.

During a late visit to Cambridge, we had the pleasure of examining the above-named piece of apparatus, which has just been added to the appliances of this observatory, and which contains many novelties of construction and arrangement (due to the invention of Professor Winlock) worthy of special notice, and without doubt generally interesting to our readers.

In the first place, with reference to its mounting.

The pivots are not supported in Y's, but on account of the great weight of the instrument, as well as for other reasons developed by experience, have journals accurately fitted to them. These journals, in their turn, are not provided with means of adjustment, but are permanently attached to plates set in the piers, and brought, by scraping and repeated trials, to the exact surface required for an accurate adjustment of the instrument once for all.

Another novelty consists in the arrangement of the setting levels and circles at the eye end, which are turned by a gear *wheel, in* place of the clamp and tangent screw, which is so apt to "run out" at a critical moment. The new movement is extremely smooth, gradual and convenient, being always ready, and never "running out."

Again, the screw controlling the horizontal wire of the micrometer in the eye-piece, beside having the graduations for parts of a turn clearly marked on the sides of its cylindrical head, in such a way that they can be easily read, has a similar graduated head connected with it by gearing, which records the whole number of turns in a like manner.

The collimating lenses used with this instrument are of unusual size, being in all respects similar to the objective, which is of 8-inch aperture, and we should judge about 8 or 9 feet focal length.

Other novelties have been introduced by Professor Winlock in the reversing carriage, by which the time required for reversal is reduced to a few minutes in place of several hours. This instrument was made by Troughton & Sims. — *Jour. Franklin Institute.*

THE LIGHT OF WINNECKE'S COMET. (COMET I. 1870.)

MM. Wolf and Rayet in a note to the "Comptes Rendus" of July 4, 1870, state that the spectrum of this comet is composed of 3 luminous bands upon a continuous ground. The extreme feebleness of the light did not permit them to determine their absolute position. Their aspect, however, appeared to be identical with that of the spectra of comets already observed. This identity of the spectra of different comets and their difference from the spectra of nebulæ leads the authors to hope that means will be found to determine the nature and origin of these singular stars.

They were struck with the feebleness of the spectrum compared with that of a nebula of the same apparent brightness. That reflected light exists in a sensible degree is proved by the fact that the light of this comet is partially polarized in a plane passing through the sun.

A NEW ASTEROID.

Dr. C. H. F. Peters, of Hamilton College, Clinton, N.Y., discoved, Aug. 14, the 111th asteroid. The planet was of about 11½ magnitude. Sept. 20, he discovered the 112th asteroid. The discovery was made on Sept. 20, and on Sept. 21; the position of the planet was established as follows: 15° and 28′ R.A., and 10° 13′ north declination. The brightness is that of a fixed star of the 11th magnitude. It is named "Iphigenia." The planet discovered the 14th of August has been named "Ate."—*Editor.*

ASTRONOMICAL PRIZE.

Professor J. Watson has been awarded by the Paris Academy of Sciences, the astronomical prize, Lalande foundation, for the discovery of 8 new asteroids in one year. The planet Lydia (No. 110), discovered by M. Borelly at the Marseilles Observatory, on the 19th of April, had at 10h. 33m. 13s. mean Marseilles time, the following position: Right ascension 12h. 2m. 39.22s. North declination 6° 50′ 38.8″. Its horary motion has been determined as follows: In right ascension, 1.76s., in declination + 2.20s.; its magnitude is between 12 and 13. M. Borelly had previously discovered 2 planets, bearing the numbers 91 and 99, in the system of asteroids revolving between Mars and Jupiter. The 91st has now received the name of Egina, the 99th that of Dike. — *Nature.*

NEW COMETS.

A new comet was discovered at the Observatory of Marseilles on the night of the 28th of August, by M. Coggia. The positions of the comet are given in the "Comptes Rendus" of Sept. 5, 1870. Winnecke discovered a new telescopic comet at Carlsruhe, on the night of the 29-30 of May. The position obtained by him for May 30 is as follows: M. T. at C. 14h. 13m. 34s.; R. A. 0h. 50m. 9.55s.; Decl. + 28° 52′ 18″.

STORMS ANNOUNCED BY TELEGRAPH.

The following bill was passed in the U. S. House of Representatives Feb. 2, and in the Senate Feb. 4: "Be it resolved, etc., That the Secretary of War be and he hereby is authorized and required to provide for taking meteorological observations at the military stations in the interior of the continent, and at other points in the States and Territories of the United States, and for giving notice on the northern lakes and on the sea-coast, by magnetic telegraph and marine signals, of the approach and force of storms."—*Editor.*

METEOROLOGICAL.

Professor H. H. Hildebrandson, of the University of Upsal, in Sweden, has prepared 4 synoptical meteorological maps, which contain several features of scientific interest. It is generally known that a fall of the barometer is usually followed by an increase of heat, and *vice versa.* But in Sweden, from observations taken from Lapland to Upsal, the barometer and thermometer frequently show results quite contrary to the general experience of more southern latitudes; the barometer often falls considerably, while during the long winter nights of this region the thermometer generally remains stationary, and when storms are prevalent invariably falls along with the barometer.

Experience shows that in those regions an intimate relation exists, not only between the variations of the pressure of the atmosphere and those of the direction of the wind, but also between the movements of the barometer and thermometer during serious atmospheric perturbations. The dampness of the atmosphere being much greater in the south-east part of the territory visited by a violent storm than at the opposite extremity, it is easy to conceive that the atmospheres at those two points possess entirely different qualities, analogous, in some degree, to those of the equatorial and polar currents.

SALT IN THE AIR.

From a series of observations, conducted with great care at Monaco, on the shores of the Mediterranean, a French scientist reports to the Academy the presence of a stratum of air 200 feet high, extending for miles inland, which is constantly impregnated with saline particles. This saline stratum, the writer asserts, is found on all sea-coasts, is independent of barometric pressure or the hygrometric state of the atmosphere, and is due to the "pulverization" of the sea-water by the breaking of the surf upon the rocks. He contends that the phenomenon he points out must not be confounded with what is commonly known as spray, which is of a coarse nature, and entirely local in character.

GEOGRAPHY AND ANTIQUITIES.

SIR RODERICK MURCHISON'S ADDRESS. AFRICAN EXPLORATION.

SIR RODERICK IMPEY MURCHISON, Bart., K.C.B., President of the Royal Geographical Society, and Member of the Institute of France, delivered an address at the meeting of the British Association, of which the following is an extract: —

"Before I speak of some few of the contributions which will, I trust, be brought under our consideration, let me glance at the rapid progress of discovery in recent years, and, first of all, at the great and important additions to pure geography which have been made in Central Asia both by Russian and British explorers. With all the western portion of that vast region in which lie the Khanats of Khiva, Bokhara, and Khokan, some of you may now be acquainted, through the accounts of Russian observers, who have already fixed the correct positions of the chief towns, mountains, and rivers of Western Turkistan. Proceeding eastwards from the Sea of Aral, the Russians have, for the first time in history, rendered the river Syr Daria (the Jaxartes of Alexander the Great) navigable by steam vessels of a limited size, and, fixing military posts on its banks, have ascended towards its sources and taken possession of the populous and flourishing city of Tashkent, a great mart of caravan commerce. Again, Russia has triumphed over the Khan of Bokhara, the savage ruler who in years gone by barbarously put to death two British officers, Stoddart and Conolly, and who has now met with a due humiliation. As peace has been concluded between the Emperor of Russia and those turbulent chiefs, who have now been rendered subordinate to a great civilized nation, we may hope that the blessings of commerce will restore this fine region to some portion, at least, of the wealth and dignity which it held in those ages when its monarchs ruled over nearly one-half of the then civilized world. The crude and ill-founded apprehensions which once existed that these advances of Russia would prove highly prejudicial to British India, have, through due reflection, entirely evaporated from among British statesmen, who are now convinced that it is much better for the commerce and peace of both nations that intermediate warring chiefs should be kept under by a strong power. After all, between the great territories of Russian Turkistan and those of British India there lies the long, broad, and mountainous region of Afghanistan, with whose present ruler we are on good terms. *But what* about Eastern Turkistan? some of my hearers may say;

what about those enormous tracts which lie immediately to the north of the north-western mountains of British India, the Himalayas, and Cashmere? The answer which I have given in my last address to the Royal Geographical Society is the most satisfactory explanation which can be offered, and I here give the pith of it. The Russians have not advanced beyond the chain of the Thian Chan into any part of those territories in which the cities of Kashgar, Yarkand, and others are situated. These countries, which until a few years ago were held by the Chinese, and are inserted in all old maps as an integral part of the Chinese empire, have entirely extirpated their conquerors, and the mass of the natives, being Mahommedans, are now under the rule of a brave soldier of their own faith, who, under the title of the Ataligh Ghazee, or leader of the faithful, has brought the people into a state of perfect order, after having been in the most tumultuous and insurrectionary state so long as the Chinese vainly attempted to govern them.

"The process by which an intercourse has been established between this Eastern Turkistan and British India has been so eminently characteristic of the efforts of a powerful trading nation like our own, that a very brief account of it may be acceptable to some of my hearers in this great mart of commerce. Tea plantations having been successfully cultivated by our countrymen upon the southern and lower slopes of the Himalayan Mountains, it occurred to a most able British civilian, Mr. Douglas Forsyth, who was diplomatically employed in Cashmere, that the population of Eastern Turkistan having been so long accustomed to drink tea, and having been entirely deprived of it since all intercourse with China had ceased, would gladly hail the reappearance of their favorite beverage, if a supply could be brought to them from the south. Mr. Forsyth accordingly sent a small sample (a horse-load only) of tea across the mountains, as a present to the great ruler of this new kingdom. As this present was 'gratefully received,' one of our British tea cultivators at Kangra, Mr. Shaw, resolved to face all the difficulties of a passage through the lofty mountains of the Karakorum and Kuen Lun; and, fitting out a caravan bearing tea, he conducted it himself in safety by Yarkand to Kashgar, where he was well received by the Ataligh Ghazee. At first, indeed, things looked unpropitious, for Mr. Shaw was proceeding fairly and simply as a British merchant, when there arrived just at the same time a warlike-looking Englishman. This was Mr. Hayward, late of the 72d regiment; and for a time both were placed *en surveillance*, but most amicably treated. In fact, Mr. Hayward had been sent out by the Royal Geographical Society to explore, if possible, that great desert plateau, the Pamir Land, occupied entirely by nomade Kirghis, in which the rivers Oxus and Zerafshan have their rise; but being unable to force his way thither through certain disturbed tracts to the north-west of the Punjaub, he took a route which led him to Yarkand. The arrival of the two Englishmen, which at first seemed so unintelligible and suspicious, turned out to be in the end most advantageous to all parties concerned; for Mr. Hayward had it in his power to fix the latitude and longtitude of places never before visited by a geographer, whilst Mr. Shaw, *dona ferens*, gratified the Ataligh Ghazee, not only by his manners and address, but particularly by his packages of tea.

"After a year's sojourn at Kashgar and Yarkand, in Eastern Turkistan, Mr. Shaw returned to British India, and the Viceroy, the Earl of Mayo, seeing the prospect of establishing a profitable alliance with this new sovereign, his Excellency not only received an envoy sent by the Ataligh Ghazee to his Excellency and the Queen, but has recently sent a special British mission to that great chief, and for this important mission he has wisely selected Mr. Douglas Forsyth and Mr. Shaw as negotiators in the establishment of a treaty of commerce between the respective countries.

"A letter from Mr. Forsyth to myself, written on the eve of his departure from Ladak, on the 2d of July last, and containing matter of great geographical interest, will be read in the course of this meeting. It will be seen by this letter that, grand as are the geographical discoveries made by Captain Montgomerie and his pundits, a grander and richer field than any yet described seems now to invite exploration. I may add that I have received a letter from the Earl of Mayo, dated the 18th July last, in which he speaks hopefully of this important mission. On our part, we have thus opened out a market for our Indian teas, and also for many articles of British manufacture, in exchange for which we shall receive not only specie, but also the fine silks and wools of Turkistan, and many mineral products of those mountains, some of the peaks of which rise to upwards of 24,000 feet, and many of whose level tracts and plateaus are 14,000 to 17,000 feet above the sea.

"To obtain a full insight into the nature of this hitherto unknown region and its remarkable ruler, I refer you to an admirably clear and telling memoir by Mr. Shaw, published in the 'Proceedings of the Royal Geographical Society,' June 7, 1870. In making these observations, I would invite some of the enterprising merchants of Liverpool, Manchester, and other places in this flourishing County of Lancaster, to transmit to Yarkand, *viâ* Bombay and the Punjaub, some of their gayest but stoutest cloths and cottons; and I venture to prophesy that the Turkistan people will rejoice in the arrival at the remote Yarkand of such British goods, for which they will gladly exchange the products of their own country or pay in specie.

"But to return to geography: Mr. Hayward, nothing daunted by his first failure, is now endeavoring to explore the mysterious Pamir Land, which no European has ever yet traversed, though Lieutenant Wood, of the Indian navy, did, many years ago, reach one extremity of it, in an endeavor to determine the source of the Oxus, as recorded in the tenth volume of the 'Journal of the Royal Geographical Society.' I earnestly hope that Mr. Hayward will be the first geographer who will have described this lofty region which the natives term, in their Eastern style, '*The Upper* Floor of the World.' If he should traverse the *Pamir Land*, I have learned, by correspondence with the Russian Imperial Geographical Society, that our countryman will then have a free passage granted to him through all Russian Turkistan. It is thus that our science makes its cultivators of every nation as kindly and considerate to each other as freemasons. Let me add that the Royal Geographical Society has awarded its founder's gold medal to this brave and energetic man; and we fervently hope that he will come home through Russia before next year, to receive his well-merited reward.

"The remarkable additions to geographical and natural history knowledge, which have been made of late years by sounding and dredging at great depths in the ocean, have excited the liveliest interest. The attention of modern geographers was long ago directed to this subject by Parry, James Ross, and Captain Denham, R.N. The last of these measured downwards in the ocean, between South America and the Cape of Good Hope, to the great depth of 7,706 fathoms, and thus enabled geographers to realize the aphorism of Alexander Humboldt, — that the greatest depth of the sea would be found to be at least equal to the height of the loftiest mountains. Subsequently Dr. Wallich, who ably served as the naturalist on board the 'Bulldog,' commanded by Sir Leopold McClintock, enunciated the then novel and surprising truth that certain marine animals (including star-fish) lived at the depth of 1,260 fathoms, and even preserved their colors when brought to the surface. More recently, the scientific explorations of the deep-sea to the north and west of the British Isles, as conducted by Dr. W. Carpenter, Mr. J. Gwyn Jeffreys, and Professor Wyville Thomson, have thrown much new light on this attractive subject. They have vastly extended our acquaintance with many submarine data, including the temperature of the sea at various depths, and have proved that currents of different temperatures — each containing a characteristic *fauna* — are running, as it were, alongside of each other, or in contiguity, beneath the surface of the sea. These data, and a consideration of the various species of marine animals which were found, are supposed to have had such material bearings on geological science that it would be a dereliction of my duty as an old geologist if I were not to endeavor to disentangle the unquestionably true, novel, and even startling facts which these researches have made known, from one of those speculations which the eminent leader of this expedition has connected with them, and which, if acquiesced in, might seriously affect the inductions and belief of practical geologists.

"Dr. W. Carpenter, in a lecture given in the Royal Institution, in summing up his views as to the effects of the discoveries then made, thus spoke: 'The facts which I have brought before you, yet still more the speculations which I have ventured to connect with them, may seem to unsettle much that has been generally accredited to geological science, and thus to diminish rather than to augment our stock of positive knowledge; but this is the necessary result of the introduction of a new idea into any department of scientific inquiry.' To this statement I beg to demur.

Sound practical geologists, whether they be uniformitarians, catastrophists, or evolutionists, like the great naturalist who now worthily presides over the British Association, are all agreed in the fundamental truths of this science as established by positive readings in the stone-books of nature. They are confident that undeniable proofs exist of an enormous succession of deposits, which have been accumulated under the seas of former periods, in each of which the physical geography of our planet, and with it the orders of animals and plants, were very dissimilar from each other, and also differ still more, as we examine backwards to the earlier deposits, from those of the present day. We believe, upon the evidences presented to us, and irrespective of all theory, that the vast accumulations under the seas of those periods have had their relations to each other thoroughly and conclusively established by a clear order of superposition. We further believe that the deposits so relatively placed contain, each of them, organic remains, which are, in great measure, peculiar to the one great group of strata which they occupy.

"With these indisputable proofs of geological succession as established by clear superposition of the formations, and the distinctive fossil characters of each, I necessarily dissent from the suggestions of Dr. Carpenter and other naturalists, that, inasmuch as the present deep-sea bottoms contain abundance of Globigerinæ, with such animals as Terebratulidæ, both of which differ little from the forms found fossil in the chalk formation, it may be inferred in a broad sense that we are still in the Cretaceous period. May we not, indeed, by a similar bold hypothesis, affirm that we still live in the older Silurian period? for, albeit no bony fishes then existed, many Globigerinæ, and creatures of the lowest organization, have been found in these old rocks and associated with Terebratulidæ and Lingulæ, the generic forms of which still live. Revering as I do those great naturalists who have shown abundant proofs of the progress of creation, or, as others term it, of evolution, I hold to my opinion, matured by a long experience, whilst I dissent from the inferences of my friends Dr. W. Carpenter and Professor Wyville Thomson, that the recent discoveries may or can unsettle much which has been accredited to what I call sound geological history, as established on absolute observations and separated from all theory. The new ideas which have been introduced by the meritorious labors of Carpenter and his associates do not, as he has suggested, diminish the amount of positive knowledge. On the contrary, they augment it; though they do not shake, in any way, the foundations of geological science. I willingly grant, however, that these new discoveries overthrow the theory that defines the depths in the sea at which certain groups of fossil animals must have lived.

"Whilst on this topic, I rejoice that at this meeting we are to be furnished with an excellent paper by my distinguished friend, Captain Sherard Osborn, on the whole subject of ocean deep-sea soundings, as carried out by the Admiralty, and in which he will *illustrate*, by maps and sections, much of his own most energetic *operations* in reference to submarine telegraphy.

"In connection with the interesting subject of the geography of the ocean, I may call your attention to a little work of great merit, which has lately appeared under the title of 'Physical Geography, in its Relation to the prevailing Winds and Currents,' by Mr. J. K. Laughton. A perusal of this book will show how wide is the field embraced by this important branch of geographical science, and at the same time how much yet remains to be done before we attain to a satisfactory knowledge of those great movements of the ocean and atmosphere included under the terms gulf-stream, equatorial current, trade-winds, monsoons, and so forth. Mr. Laughton, in the book to which I allude, has called in question the accuracy of the prevailing theories intended to explain these grand and, in some respects, complex phenomena. The received hypothesis with regard to the trade-winds, for example, first outlined by Halley towards the end of the seventeenth century, but developed by Hadley about 50 years later, and modified a few years ago by Maury, he shows to be quite inadequate to explain all the facts of the case. This hypothesis, as is well known, assumes that the lower strata of the atmosphere near the equator, being overheated by the sun's rays, expand and rise into the upper regions of the aerial envelope, their place being taken by a cooler air, which rushes from the higher latitudes of the north or south as the case may be; and, moreover, that the ascending heated air travels backwards, as an upper current, to the latitudes where the cool wind originates, and then, descending again, the aerial circulation is completed. One of the most striking objections made by Mr. Laughton to this explanation is that the equatorial zone is far from being the hottest part of tropical and subtropical regions. He shows, as a matter of fact, in the North Atlantic basin, that the Great Desert of Sahara has a temperature from 20 to 50 degrees hotter than the equatorial zone; yet, so far from a cool current of air being drawn in from the Atlantic towards this heated region, the north-east trades pass straight onward in their southerly course without the slightest indraught towards the African coast. He also shows that there is no proof of a vertical movement of the air at the equator, or in the latitudes where the upper currents are supposed to descend again. A multitude of similar or parallel instances are adduced from other parts of the earth; in fact, nothing has more surprised me, in perusing the work, than the great amount of reading and research the author has applied to the elucidation of this and kindred problems. Having shown the untenability of the received hypothesis, he modestly advances a new one of his own. This is difficult, perhaps, to explain in a brief manner. But he shows, from the most varied evidence, that the general movement of the atmosphere over the whole earth is from west to east; and that in regions where the prevailing winds at the earth's surface are not westerly, an upper and strong westerly movement exists above the lower winds. The trade-winds, monsoons, and all other partial atmospheric movements he shows to be chiefly eddies and reflected currents of greater or less constancy; and he confirms this supposition by an exhaustive examination of the laws of movement of air and other fluids. I may say, in short, that even those who may not agree with the author's reasonings will find both pleasure and profit in studying the rich store of observation and lucid argument contained in this little work.

"Among the many interesting papers which will be read before you during the present meeting I may announce two, on subjects of great general interest, by General Sir Henry Rawlinson, — one on the Site of Paradise, and the other on the River Oxus, — both the fruits of long study and research, and sure to be listened to with the attention that everything emanating from so distinguished a geographer and philologist so well deserves. An important communication from Dr. George Campbell on the Physical Geography of British India is also expected, — a subject which has been for years a special study of the author, during his residence in a high official position in India. Mr. T. T. Cooper, a traveller who has distinguished himself by his persevering endeavors to traverse the difficult country between Western China and our Indian possessions in Assam, will read a paper on Eastern Thibet, in which he will dilate on the commercial bearings of his explorations, which were undertaken with a view to discover a route for an overland trade between the populous and productive regions of the Yang-tsze-Kiang in China and the equally rich and densely populated plains of British India. With regard to Africa, — that great continent which still continues the principal field of geographical enterprise, — I have to announce that Mr. Winwood Reade, who has recently returned from an exploration undertaken under the auspices of the Royal Geographical Society, and at the cost of an enlightened merchant, Mr. Andrew Swanzy, will communicate to the section an account of his hazardous journey to the Upper Waters of the Niger and to the Bouré country. Mr. Reade explored a portion of the Niger not previously visited by any European traveller, and opened up a tract of populous country, in which is situated the town of Farabana, containing 10,000 inhabitants, previously unknown to geographers.

"In respect to those portions of Central America with which many readers have become acquainted through the descriptions of Stephens and Squier, I may inform you that you will be interested in a communication from Captain J. Carmichael upon countries occupied by the Indians of British Honduras and Yucatan. Ascribing an Eastern, and probably an Egyptian, origin to the earlier buildings and temples of the aboriginal American Indians and their idols, the author, who has explored the regions he describes, and speaks their language, endeavors to throw additional light on the subject. He confesses, however, that in these mysterious monuments he finds as much difficulty in assigning them definitely to any race of men as British and other authors have had in fixing the origin of our own most ancient monuments at home, such as Stonehenge and other Druidical remains. He differs from Stephens and Squier, and those authors who *do not assign* a great antiquity to these reliquiæ, and shows that when the Spaniards took possession of the country several of the colossal buildings and temples had even then a very antique appearance. Captain Carmichael discusses with spirit the question of the former use of the huge and lofty tumuli which abound, and suggests the probability that many of the well-chiselled and beautifully formed stone buildings and ornaments were fashioned into their present shapes by stone implements only, all the arrow and spear heads which he found being made of obsidian. The Indian king of these parts had a palace at Guiche, which, according to Torquemada, rivalled that of Montezuma, in Mexico. The enthusiasm with which Captain Carmichael describes these old ruins will, I hope, secure the attention of the section.

"Two of our secretaries, Mr. Clements Markharm and Mr. Major, will communicate papers, — the first being an outline of an elaborate work he is preparing on the history and progress of all the surveys in India; the latter on the long debated question of the so-called Land-Fall of Columbus.

"Governor William Gilpin, of Colorado, who has recently reached our shores from that grand central region of North America, will, I trust, favor us with a sketch of that rich metaliferous, mountainous country, which 10 years ago he thoroughly described, when he energetically advocated the execution of that gigantic railroad which now happily connects the Pacific and Atlantic Oceans.

"A strong desire on the part of the council of the Royal Geographical Society to induce the heads of our public schools to promote the study of geography, on a plan prepared by Mr. Francis Galton, led us to offer annually 2 medals, to be competed for in an examination directed by the Society. It gratifies me to announce in this town that in the 2 years during which these honors have been distributed, the medals adjudicated each year have been won by young men in the public schools of Lancashire, namely, Liverpool College, and Rossall School, near Fleetwood. When we consider that all the leading schools of the United Kingdom were invited to compete for these honors (and several of them did so compete), the fact which I have just mentioned does great honor to this prosperous mercantile county, which among its rising generation doubtless contains many a young aspirant to win the fame of Raleigh.

"I may conclude this address by dwelling, for a few moments, on the topics which, of all others, most interest myself, and I doubt not, the great majority of my countrymen, — the explorations of inner equatorial Africa by Sir Samuel Baker, and of Southern Africa by Dr. Livingstone. Sir Samuel, being thoroughly well supported with those appliances which the Viceroy of Egypt has so liberally afforded him, will surely add largely to our acquaintance with the vast central and watery region on either side of the equator. A letter which he wrote to me from Khartoum, in March, 1870, stated that, having received in sections, on the backs of camels, all the vessels of his river and lake flotilla from England, as prepared by Mr. Samuda, he was full of hope and confident of success. Recently, I have received a longer and most interesting letter from him, which will be read at the present meeting, and which graphically details the difficulties over which he has triumphed to the present time.

"We learn from this letter that Baker, starting from his station on the White Nile, in lat. 9° 26′, next November, can only reach Gondokora much later than he anticipated; we have further to reflect upon the fact that, after arriving at that place, his great difficulties would commence; for, in the Bari country, peopled by negroes who have been rendered furious and wretched by cruel slave-dealers of various nations, he would also have to transport all his vessels and materials along the right bank of the Nile, where the great stream flows over granitic rapids. He has also to carry all his goods over the Assua River, a great tributary of the Nile, by a wire or chain bridge, which he had to construct. Having vanquished these obstacles, and having reached that portion of the Nile in which his vessels could be launched, he would then sail up the stream until he reached his own great lake, the Albert Nyanza. This accomplished, and cheered by his charming and devoted wife, he would be thoroughly master of a position wholly unprecedented in the history of African discovery.

"As I have already alluded to a very barbarous tract through which he would have to pass, and which was formerly traversed by Speke and Grant, I would observe that it is specially to such tracts that Baker holds instructions from the Khedive to extirpate the cruel slave-dealers who have brought about these horrors by the robbery of their ivory from the natives, and the capture of women and children. I specially make this allusion, because a mistaken notion had arisen in Egypt that Sir Samuel proceeded on a mission to abolish slavery altogether. Now, as every Egyptian household contains slaves as their only domestic servants, we learned from our associate, Lord Houghton, when he visited the Suez Canal, that the Egyptians were much prejudiced against Sir Samuel. But no such Quixotic, and I might say impossible task has been assigned to Baker, for domestic slavery is ingrained in all parts of Africa as a regular institution of the land. Atrocious and cruel slave-dealing and robbery may, however, be thoroughly put an end to; and this my friend has already commenced, through the agency of Egyptian soldiers. Of his energy in these philanthropic measures you will have a pregnant proof in the letter which will be read to you. In this way the poor African serf may be assured that when he sows his grain he will reap a crop at a future day.

"I can well imagine the delight with which Baker will define with his flotilla the western boundary of his great lake, and delineate the course of those lofty mountains on its western shore which he had only seen at a great distance in his former journey. We may also picture to ourselves how he would rejoice in exploring wide tracts of that vast unknown interior in which large bodies of water lie, which are supposed to feed the Congo. The point of the compass, however, which will be first sought by the intrepid *voyager* will, I doubt not, be the southernmost end of the Albert *Nyanza,* because it is there that he hopes for the happiness of falling in with and relieving his great contemporary Livingstone. If, indeed, that indomitable missionary, who unquestionably stands at the head of all African explorers, should succeed in tracing a connection between the waters of the Tanganyika Lake, where he was when we last heard from him, and the south end of the Albert Nyanza, why, then, the meeting of these two remarkable men will be the happiest consummation of our wishes. And if that should be accomplished, Sir Samuel Baker himself will, I doubt not, cheerfully award the greater share of glory to his fellow-explorer, who will then have proved himself to be the real discoverer of the ultimate southern sources of the Nile. In waiting for the solution of this great problem I adhere, in the mean time, to the opinion which I previously expressed, that if Livingstone be still at or near Ujiji on the Lake Tanganyika, to which place supplies have been sent to him, he will at once proceed to determine that problem, and will not think of a return to England until the grand desideratum is carried out. Judging, indeed, from his own original observations respecting the course of those rivers which take their rise in 8° to 9° S. lat., and believing as he did that most of them flow by the western side of Lake Tanganyika, and do not enter that lake, it seems to follow, that in pursuing a N.N.Westerly direction several of these waters must feed the Congo and so issue on the west coast. If such should prove to be the fact, why, then, this great traveller will have been the first to determine the true sources of both the Nile and the Congo.

"And here I would ask why any one who knows what Livingstone has undergone should despair of his life simply because we have had no news from him during the last 15 months? Did not much more than that period elapse whilst he was in the heart of Africa without our receiving a word of comfort respecting him? By the last accounts he was hospitably received by Arabs who are friendly to the Sultan of Zanzibar, who is Livingstone's patron, and also a protector of the negroes. I have received a letter from Dr. Kirk at Zanzibar, dated 29th June, 1870, which has comforted me exceedingly; for, sanguine as I have been as to the safety and success of Livingstone, I am now better supported than ever in my anticipation of his ultimate triumph. Dr. Kirk thus writes: 'News has reached me by natives from the interior that the road is now clear, and that the cholera did not pass the town of Unyanyembé. Livingstone is therefore out of danger, and I hope the stores sent have now reached him. The rainy season being at an end, Unyamwezi caravans are daily expected, and will no doubt bring, if not letters from the doctor himself, at least news of him from the Arab governor of Unyanyembe. The coast near Zanzibar is now healthy.' Looking, then, as I do, to the astonishing and enduring resolution of my friend, and his thoroughly acclimatized constitution, remembering that he has already gone successfully through privations under which even his attached negro youths all succumbed, I still hold stoutly to the opinion that by reaching the Albert Nyanza he will determine the great problem of the water-shed of South Africa, and then return to embrace his children, to whom he is devotedly attached, and receive the plaudits, not only of his admiring countrymen, but of all civilized men. Should this happy finale be brought about, he will have the great additional delight of finding here his venerable father-in-law, the Rev. Robert Moffat, who, after half a century of successful missionary labors, is present at this meeting of the British Association.

"In conclusion, I have the honest satisfaction of knowing that, as president of the Royal Geographical Society, and as the sincere friend of Livingstone, I have, with the warm aid of my deeply lamented friend, the Earl of Clarendon, been successful in urging our government to relieve the great traveller who was gazetted as her Majesty's consul to all the kings and chiefs of the interior of Africa. I have only to add that if diplomatists are recompensed according to the energy and capacity with which they execute their duties, I confidently anticipate that, on his return to Britain, this undaunted envoy to unknown lands, this sound geographer and zealous Christian missionary, will not only receive a becoming pension, but will also be honored by some distinction of the crown, which assuredly our beloved queen will gladly confer upon him.

SIR SAMUEL BAKER'S EXPEDITION.

The following letter to Sir Roderick Murchison was read at the meeting of the British Association: —

"TOWFIKEEYA, WHITE NILE, Lat. 9° N. 26′, AFRICA,
15th June, 1870.

"MY DEAR SIR RODERICK: — I have established a station at this important point of the Shillook country, in which I shall pass the rainy season. I have erected galvanized iron magazines, 200 feet in length by 20 in width, within which I have stored all provisions and materials, and my flotilla of 53 vessels lies moored along the wharf. The troops and Europeans are in fair health; they are housed comfortably for the wet season.

"Mr. Higginbotham (engineer-in-chief), after great exertion and untiring energy, succeeded in transporting the steamers and machinery across the desert to Khartoum, with which he followed me up the White Nile. All branches of the expedition thus happily effected a junction without the loss of either a European life or that of a horse, although many of the latter had been brought so great a distance from Cairo.

"Thus far all has been successful. We are in excellent health, and I am fortunate in the possession of such trustworthy aids as my nephew, Lieutenant J. A. Baker, R.N., and Mr. Higginbotham, to whom I am extremely indebted, as they relieve me from much toil and anxiety. The steamers and other vessels which failed in the passage of the cataracts between Cairo and Khartoum will, I trust, join me here before November, as I propose leaving this during the first week of that month with reinforcements for Gondokoro.

"The great difficulties experienced by Mr. Higginbotham in the passage of the Nubian desert with so large a caravan of upwards of 1,800 camels, laden with unmanageable loads of material, caused a delay which lost the favorable season for the White Nile voyage. The unfortunate festivities attendant upon the opening of the Suez Canal had also delayed my departure from Egypt, as no steamer was disengaged. The failure of the passage of the cataracts by the 6 steamers and large-decked vessels from Cairo was a severe embarrassment, but the climax to the series of *contretemps* was the total want of preparation at Khartoum, where I had expected to have found an organized fleet upon my arrival from Egypt, according to my instructions given some months beforehand. These delays are inseparable from African affairs. Thus, instead of starting from Khartoum in December, we left on the 8th of February. Previous to my departure from Khartoum I was assured that the Great White Nile had ceased to be a navigable river!

"If you refer to my work, 'The Albert Nyanza,' you will remember my description of the dam formed by floating rafts of vegetation, which, by accumulation, has caused an obstruction in the river before the junction of the Bahr Gazelle and the Bahr Giraffe. It appears that since my passage of the river in 1865 the dam has been entirely neglected by the authorities at Khartoum, and the river, thus left to its own vagaries, has exemplified the principle that has formed the weary wilderness of marsh and decomposing vegetation that marks the course of the White Nile.

"The vast masses of floating islands continually brought down by the stream have now formed an addition to the dam, and have produced a new district of many miles' extent beneath which the river passes by a subterranean channel. Thus the White Nile has literally been closed to navigation. The slave-traders, thus shut out from communication with their old field, had discovered a passage to Gondokoro through the Bahr Giraffe.

"In the 'Albert Nyanza' you will see that I declared the Bahr Giraffe to be merely a branch of the White Nile, quitting the main river in the Aliab country, and that it was not an independent stream like the Probat, as laid down upon former maps. This is proved to be correct.

"I left Khartoum with 5 guides, intending to adopt the new route, *via* the Bahr Giraffe. On the 17th of February we entered the mouth of the river in N. lat. 9° 26′. The water was 19 feet deep, and the current about 3½ miles per hour, with a breadth from bank to bank of about 60 yards. At the time the surface was about 5 feet below high-water mark.

"The mean course of this winding river was from the southwest. Four small granite hills formed unmistakable landmarks in the boundless flats within 15 miles of the junction. Fine forests bordered the river for about 30 miles, diversified by plains of extremely fertile soil. Beyond this the wood was scarce, and the forests were at intervals of 70 or 80 miles. As we proceeded the wood ceased altogether, and the steamers depended upon the supply of fuel which I had stored in vessels in tow.

"At the distance of about 180 miles from the junction the dry land disappeared, and we sailed through endless marsh, where the river narrowed to a width of about 40 yards. It was in a deep, narrow channel that we were nearly wrecked by a savage hippopotamus, which recklessly charged the boats, breaking 3 floats from the steamer's paddle, and then, striking my iron diahbeeak, he cut 2 clean holes through the bottom plates with his sharp tusks, and we should have sunk in 10 minutes without the assistance of the steamer's crew and engineers.

"As we drew nearer south the rapidity of the current diminished, the river narrowed to a width that would barely admit the passage of the steamers when rounding the sharp bends. By degrees the channel disappeared, and the flotilla became fixed in a boundless sea of high grass. This was in lat. by observation 7° 47′ 46″, and by dead reckoning 272 miles from the junction of the river with the Nile.

"Our guides, nevertheless, declared that the White Nile could be reached by this route, should we cut a passage for the boats through the floating marsh and swamp grass. The task appeared hopeless, as no sign of open water could be distinguished from the masthead, and the quality of the marsh resembled sugar-cane in thickness and toughness, while the tangled confusion of decaying vegetation for a depth of 5 or 6 feet could only be compared to a mixture of fishing-nets, ropes, mud, sailors' swabs, sponges, and canes, all compressed together in a firm mass, beneath which the water was from 10 to 12 feet deep, while grass about 9 feet high covered the surface to all points of the horizon.

"With about 1,000 men we worked for 32 days, and cut about 8 miles of canal, through which, by dismounting the paddles, we warped the steamers, and with immense labor we succeeded in pushing the flotilla through a chain of small lakes separated from each other by intervals of marsh. These lakes we discovered from time to time as the canal progressed, and the intervening marshes between them formed a total of 8 miles' cutting, which enabled us to traverse a distance of 32 miles. The sight of open water from time to time was cheering to the men, fatigued and sickened by hopeless labor in mud and stench. We at length reached the unmistakable open river; dry land appeared on either bank, and forests within 2 miles. Herds of antelopes and buffaloes were on the plains, and the rifles secured a supply of meat which was much needed. The whole force rejoiced in the prospect of reaching the Great White Nile, and the flotilla of 34 vessels sailed merrily on. Suddenly the steamer grounded, and one by one the other vessels followed the example. There was no depth of water.

"My diahbeeak, being of iron, had a light draught, and I pushed on in advance for about 3 miles, carefully sounding the channel. The general depth was only 3 feet. The steamers and heavier vessels required 4 to 6 feet. At length the light diahbeeak grounded in water only 2 feet 6 inches in depth. Quitting the vessel, and accompanied by my nephew, Lieutenant J. Baker, R.N., I proceeded in a small rowing boat, hoping that we might find deep water before us. We were quickly beaten, as the channel divided into 3 branches and once more flowed through vast marshes. There was not sufficient water for the rowing-boat, and she grounded upon a bed of sand. The river was impassable. On the following morning I attempted a survey of each channel, but all were alike impassable. The painful fact was established that the route by the Bahr Giraffe is only practicable during the season of flood.

"The rainy season was close at hand. Already we had suffered from several storms; provisions were damaged; 160 men laid down with marsh fever; some lives had been lost, and I daily expected the arrival of Mr. Higginbotham and party from Khartoum, who, with a small force, would have been helpless in the ever-closing marshes. The floating masses in many instances closed the newly made channel a few minutes after the passage of the vessels; thus a weak force might be hemmed in like a ship by ice-floes in the Arctic Sea.

"I had beforehand determined that in the event of an insurmountable obstruction, I would form a station at a convenient point upon the White Nile, at which I could unite all branches of the expedition, and prepare for the favorable season in November. We therefore quickly retraced our steps, cutting through those portions of the canal which had closed; and, remounting the paddles of the steamer, we ran down the Bahr Giraffe at 10 miles an hour, in advance of the flotilla, and took up a position for wood-cutting in a forest on the Nile banks, within 6 miles of the Bahr Giraffe junction. At this point we were joined by Mr. Higginbotham and troops from Khartoum, together with the sections of steamers and machinery which he had so ably conducted through the desert journey from Cairo. Dr. Gedge and the 6 English engineers and mechanics were also with him in good health and spirits. My exploration of the Bahr Giraffe had saved them much difficulty; but this was not the only good of my return.

"The Turkish governor of a settlement on the lower White Nile (Fashoda), thinking all chances of detection impossible, had made a razzia on this portion of the Shillook country, and was kidnapping slaves and cattle under the pretence of collecting taxes. Having received this information from the people, I came suddenly upon him with 2 steamers, and caught him in the act with 150 slaves (women and children), 71 of whom were crammed within a small vessel. He was accompanied by about 350 soldiers, exclusive of a few irregular cavalry, with which force he was harrying the country. I insisted upon the immediate liberation of the slaves, and, as the poor people were within sight of their villages which had been so recently pillaged, I had the satisfaction of returning them to their homes, to their great astonishment and to the confusion of the slave-hunting governor.

"I then made an excursion to seek for a favorable locality for a permanent station, and succeeded in discovering the spot from which I write, — a convenient position on the east bank of the White Nile, opposite the Shillook country, with which tribe I have established the most friendly relations.

"The Egyptian Government established a station 6 years ago within the Shillook country for the purpose of suppressing the slave-trade; this station (Fashoda) is in north latitude 9° 54′ 25″ by observations taken during this journey. No improvement has been effected by the representative of the government; but the entire country is a scene of anarchy and confusion, the governor setting the example of pillage. There can be no doubt that the Shillook with good government would become a valuable portion of Egyptian territory. The soil is the most productive; the population is estimated at a million, and the natural production is cotton. Rice and several species of vegetables grow wild, including the grape, vine, and asparagus. The country abounds with forests of pine timber, and the river is without obstruction direct to Khartoum.

"At present there is no trade, as the natives have no encouragement from the authorities, but with fair dealing and security of life and property the entire Shillook country would become an extensive cotton-field. Although generally naked, the natives demand cotton cloths, which they receive with eagerness in barter for supplies. They have already commenced an exchange of their cotton for manufactured goods; but the quality of their cotton being inferior from the absence of cultivation it would hardly bear the cost of transport. I shall introduce during this rainy season the cotton-seed that I brought from Lower Egypt; this I shall give to the chiefs, who well understand the advantage of an exchange of their natural productions for manufactures. The people are naked from necessity, and not from choice.

"As the camp is now completed, I shall turn all hands to cultivation. I have now 1,500 men who will be employed in agriculture, to produce during the rains the supplies of corn that will be required for the advance in November next.

"The advantage of this settlement was proved shortly after our arrival by the capture of a slave-vessel that attempted to pass the station. Upon this boat I found 150 slaves packed like sardines, and concealed beneath the fore and aft decks. The slaves were liberated, their names registered, and each individual was given a ticket of freedom. The commanders I have placed in irons. One of the first works of my English blacksmiths was to cut through the chains that secured the unfortunate children. Thus I have already had the satisfaction of releasing 305 of these miserable creatures, mostly women, young girls, and boys. I have no doubt his Highness the Viceroy will appoint some trustworthy person to command this station after my departure.

"I have received information from the Shillook chiefs concerning a new channel that the river has formed, connecting the upper and lower portions in the region of the dam. They declare this to be navigable, and they have offered their services as guides. I intend to make an exploration with their assistance when I shall have completed my arrangements in this station. I shall take 2 steamers and 2 diahbeeaks in tow, with 50 or 60 men. Should this good news prove to be correct, there will be no difficulty in November next, as I shall return here with an accurate knowledge of the passage. Should there be no navigable passage, I shall cut through the great dam and open up a permanent channel, with a force of 2,000 men.

"I am thankful that Lady Baker and myself have been free from all ailments. My 6 English mechanics are industrious and well-conducted, and are good representatives of the working-classes of England, in a difficult and trying enterprise, where patience and stability of character are necessary elements. The Egyptian troops are orderly and resigned; the black soldiers are full of vigor.

"I regret, my dear Sir Roderick, that I cannot yet give you much geographical information; but this expedition is not one of simple exploration. There is a grave responsibility with so large a force in Central Africa, far distant from supplies, and much caution is required in the advance. Pray God that we may meet again, my dear friend. With much love from Lady Baker and myself, ever affectionately yours, SAMUEL BAKER."

Sir Roderick Murchison, at the conclusion of the letter, said that Sir Samuel had given an earnest, by what he had already done, of what he would accomplish. It was gratifying that he was putting into execution that act of the Viceroy, to stop the pillage of villages and the abduction of the women and children.

STONE IMPLEMENTS OF WESTERN AFRICA.

Sir J. Lubbock, Bart., F.R.S., at the meeting of the British Association, delivered some interesting remarks on "Stone Implements from Western Africa." He said that, considering, of all the great continents of the world, Africa was probably the most backward in civilization, it was remarkable how deficient it was in stone weapons. He thought this was no doubt owing to the abundance of sands containing iron, and the facility with which iron was obtained and prepared for use. This infrequency or almost absence of stone implements in Africa had been alluded to on various occasions by those who had found a difficulty in reconciling it with the well-founded theory with respect to stone having preceded metals; but although stone implements were rare, they were not altogether unknown. He (Sir John Lubbock) had brought some which had been sent from the Cape of Good Hope. The spear-heads in the collection had a remarkable similarity to the spear-heads which were found in Europe and elsewhere. He believed that never before from this place had anything been discovered that could be called an arrow. Sometimes small articles of stone were called arrows which should not be called so. It might very well be believed that a savage would be very careful indeed in the manner in which he manufactured his arrow-heads. It took him, perhaps, a day or two to get near his lurge, so that it would be very provoking to him to lose his game, and it would, therefore, be an economy of time to bestow a considerable period on the manufacture of arrows which would be tolerably true, and would give him a chance of killing his game. This being so, nothing should be taken for an arrow-head which did not present the indubitable features of that weapon. The scraper, which was well known in Europe, was not much represented in Africa, and the specimen which he (Sir John Lubbock) had got from the Cape of Good Hope was the only specimen of the type which was known. Sir John also exhibited several stones, with respect to which he said there was a notion that they were thunderbolts, and in consequence they were used as charms, and also ground down and drunk in water as medicine. It was only when the remembrance of these things passed into tradition, and they had ceased to be used in every-day life, that they became mysterious, and were used for medicine and as charms. The depth at which these stones were found showed that they were not of yesterday, but could not be taken as evidence that they were of great antiquity. Exhibiting an axe of stone from Western Africa, Sir John placed beside it several similar weapons from various parts of the world, pointing out that they were all of a very simple character. In conclusion, he objected to the opinion which was very generally entertained, that anthropologists considered that all stone implements belonged to the stone age, that all bronze articles belonged to the bronze age, and all iron articles to the iron age. Still, considering the abundance of ores of iron in the district from which his specimens had been brought, and the facility with which they could be smelted and metals obtained, and yet stone had been made use of, they must believe that the stone axes belonged to the time before the negroes of the Cape had become acquainted with metals.

FLINT FLAKE CORE.

Mr. John Plant, F.R.A.S., at the meeting of the British Association, read a " Note on a Flint Flake Core from the River Gravel of the Irwell, Salford, Manchester." He said the upper valley of the Irwell was overspread with till and sandy layers. Terraces above 200 feet in elevation were very distinct in places. The river now flowed over the beds of new red sandstone, having contracted its bed from at least a mile to about 60 yards. The upper terrace was composed of sand and gravel of older age than the silts which fringe the banks. The pebbles of gravel were mainly derived from the pebble-beds and eroded till; others were flattened pebbles from the coal-measure. Throughout these pebbles it might be said there were no flints, buts of chert only from mountain limestone. The weapons of Lancashire were neolithic *in character*, so that the occurrence of a flint flake was remarkable *from its site* in the barren desert of gravel and sand of the Irwell.

Mr. Plant thought the specimen he exhibited belonged to the time when the East of England was in the occupation of the early palæolithic people of Europe.

MR. EVANS ON ANTHROPOLOGY.

The following address was delivered at the meeting of the British Association, in the department devoted to ethnology and anthropology: —

After showing that the wide area of the sciences is not like that of our inhabited world, broken up by various natural boundaries into numerous kingdoms or empires, each speaking its own tongue, and striving to maintain its independence of its neighbors, even when not directly antagonistic to them; but rather resembles that of some great globe without any such geographical divisions, occupied, it is true, by various races, each having a distinct centre, where its own peculiar language is spoken with the utmost purity, but around those centres gradually intermingling with the other surrounding races, so that in the border land between any two such points it is often difficult, not to say impossible, to say to which of the two races the inhabitants belong, or to assign any fixed limit to their respective provinces; he said: —

"The main, central point — the history of the origin and progress of the human race — must, however, be that around which all our thoughts must revolve, and towards which all our investigations must be directed. He thought that any one who will contrast our present amount of knowledge — limited though it be — of the history of man, with what was known concerning him even so lately as 20 years ago, will see how much has been accomplished during that period, as compared with the hundred-fold greater period which has elapsed since the days of the old Greek philosophers, the results of whose inquiries sufficed for the curiosity of so many subsequent generations. For though in earlier days there were some, at all events, who were not content with the prevailing views as to the origin and antiquity of man, and as to the course of human civilization, yet they were unable effectually to influence the current of opinion; and their speculations, when occasionally they are now, as it were, disinterred from their writings, seem like some recent organisms accidentally imbedded in one of the older rocks, or at all events to present what some geologists have been pleased to term 'prophetic types.' We have now, I think, arrived at a point when it is almost unanimously admitted by all candid inquirers who from the extent of their studies are competent to form an opinion on the subject, that the family of man dates back to an epoch far, far more remote than the 60 centuries or so allowed by Bishop Ussher's chronology; that the universality of the Noachic deluge can no longer be maintained; and that there has been a progress — more or less interrupted, it is true, in different places and at different periods — in the arts and appliances of human industry, from the first appearance of man up to the present time, and, therefore, that human civilization is progressive, whatever may be its relation to the human mind and intellect. These views, moreover, supported as they are by direct evidence accessible to all, are held not merely by a select few, but by a large and increasing number of those interested in various branches of science, so that it does not require any peculiarly sanguine temperament to regard them, if not as actually established truths, yet, at all events, as in a fair way of being no less generally accepted than any of the fundamental doctrines of astronomy or geology. To have overcome prejudices even to this extent, and to have a free course for future investigation, is, indeed, a great step gained; but how much have we still to learn, and what an infinity of details have still to be inserted before any single picture of human progress, taken from any point of view, can be regarded as complete! The principal means we have at command towards solving these and numerous other questions bearing on the origin and progress of mankind, is diligent observation and collection of facts, from which, in due time, some general laws may be induced, so that these, in their turn, may serve to explain other facts, until gradually a system may be built up in which all phenomena find their proper place, and become mutually illustrative one of another."

After showing that the regions in which these facts are to be collected are neither few in number nor uniform in character, he said: —

"The great fact, which we cannot too steadily bear in mind, is, that we of the present day, our words and works, and all the surroundings of our life, are merely the last links in one long, complicated, though continuous chain, which connects us with our remotest forefathers, their language, implements, and associations. We must never forget that each generation, with all its accompaniments of whatever kind, forms a link in that chain, and stands in the most intimate and close relationship with that which went before and that which immediately follows it; and, further, that though in countries now possessed of civilization its rate of progress may have varied, or even alternated with retrogression into barbarism, yet that these changes have been by no means sudden, but that all external civilization and all human appliances, whether modern or ancient, have been the result of more or less slow evolution from a lower stage of culture, and from ruder or more simple forms; while, in case of their decay or degradation, it has been by a gradual process of longer or shorter duration. It is this continuity in all the accessories of the external life of man that renders any knowledge we may gain concerning their form and character, at any given remote period, of such value in reconstructing primitive history, and which renders the study of the development of modern appliances, and of their relation to the culture and mental condition of those who use them, so illustrative of the different phases of civilization.

"The story told by all the appliances of civilized man, whether in ancient or modern times, and in a less degree by those of barbarous and semi-civilized nations, is invariably one of progress, even though many of the forms in use may be mere resuscitations of what have been developed in more ancient times under probably somewhat analogous circumstances. There can, indeed, be no doubt that every material object we use, however recently invented, bears upon it the reflection, more or less distinct, of something which has gone before; so that, in fact, each newly invented appliance is but the descendant from some other of earlier date; and though varying from it in a greater or less degree, yet still deriving its form and character by the way of legitimate descent. The rifled cannon of the present day is a modified descendant of the smooth bore; and this (if history is to be believed) of the mortar of Friar Bacon, which, in its turn, was an improved form of the first pounding apparatus, — a slightly hollow stone on which to pound, and a pebble to use as a pestle. The reaping-machine, whether of the present time or of the days of Pliny, is but an adaptation of the iron sickle, which traces its ancestry through the family of bronze sickles and knives to that of the old flint flakes. It is, in fact, the old story, — the force of which had, however, been but so recently appreciated, — that of constant tendency to change, accompanied by the survival of the fitted forms for the sphere in which they are placed; and in the same way, as the most eminent living naturalist conceives it not only possible but probable, that all animals have descended from, at most, only 4 or 5 progenitors, and all plants from an equal or lesser number, so I think that an examination of the history of human arts and manufactures will reduce the material appliances possessed by our first progenitors to at least as small a tale.

"We may, indeed, reverse the comparison of Darwin, and, instead of arguing from complex pieces of machinery to organisms, regard the mechanical contrivances of man in the same manner as the naturalists of his method of thinking would regard some organism. In some instances, and especially in the case of ornaments, the rate of change may be very rapid. A better illustration of this can hardly be found than in tracing back the bonnets of ladies of the present day to the broad-brimmed hat of the last century, of which it is the direct descendant, and to which the most modern forms now show a tendency to revert. But whatever may be the amount of persistency or of variation in form, there can be little doubt that in almost all cases the farther back we trace any instrument or appliance, the simpler shall we find it, both in form and material. The normal transition is, of course, from the use of the well-known division of the stages of human culture into those of stone, bronze, and iron, and is one which in all probability will be found to hold good in every portion of the globe, the occupation of which by man extends back to an epoch more than 2,000 or 3,000 years remote from the present time. Much mischief, however, may be done by regarding all ancient objects of stone or bronze as of necessity belonging to the stone or bronze age, and by using these terms as if they had some chronological signification, instead of their being merely convenient forms of indicating, in a succinct manner, certain stages of culture."

The Professor then directed attention to language as one of the sources from which facts concerning man's history are to be derived. "It is," he said, "needless for me to dwell on the value of language as affording perhaps the best and safest clue to ethnological affinities; nor need I do more than allude to the proofs of the antiquity of man afforded by the variations of modern languages from their parent stock, — variations which are so great that some languages of common descent have now hardly a dozen words in common, and which must have required an enormous lapse of time for their production; and yet the main features of which we find already established some 2,000 or 3,000 years ago. But even in minor details the evidence of language may prove of immense service, though such has been the nature and extent of the changes it has undergone, and so few are the monuments of some of its phases, that there is often much difficulty in extracting satisfactory testimony upon any given point. When we consider the essentially persistent nature of language, its continuity from generation to generation, each introducing but few intentional changes, and each believing that it speaks what is happily termed its mother tongue, we might, in the absence of other evidence, find a difficulty in accepting the bare possibility of such extensive modifications as it has undergone. But language, and especially unwritten language, is curiously plastic; and all changes in manners and customs, and in the appliances of life, must of necessity influence the methods of expression. When new discoveries are made, or new appliances introduced, new terms also come in; but these, like the inventions and objects themselves, are always more or less connected with something that has gone before. In process of time, these terms, which originally bore a distinct meaning in themselves, may become slightly changed in form and even in their application, so that all traces of their first derivation may be lost or partially concealed. But what an amount of history is there crystallized in words, and what aid would be afforded in unravelling the tangled clue which guides us along the course of human progress, were we able to trace only each substantive to its origin, and fix its age and native place!"

The Professor next referred to another and fruitful field of observation, — the ground beneath us, — and in the course of his remarks said: —

"It is impossible in any way to foresee what other discoveries the strata beneath us may have yet in store for us; but certainly there is no reason to conclude that we have as yet found the earliest traces of man upon the earth, or even on the soil of Western Europe. At the same time I must confess that the present amount of evidence of human existence in Pliocene, and even in Miocene, times in France, appears to me, after a careful examination of it on the spot, to be very far from convincing. Should the remains of Miocene man be eventually discovered, it will be of the highest interest to compare his form with that of his contemporary and equal in stature, the Dryopithecus, which was sufficiently human in habit to retain its wisdom-tooth still undeveloped in its jaw after all its milk-teeth had been replaced by the second set."

The Professor next showed that in the same manner as our language and appliances are derived from and indissolubly connected with those of the generations which have gone before us, so it is with the laws, manners, and customs, and, within certain limits, the beliefs, morals, and religions of the present day. "How many of our legal and social customs belong to a totally different stage of society, and, like the parts which have become rudimentary in organisms, survive only as memorials of a past condition of things! As single instances, take most of the customs relating to copyhold lands, — the admission to them by a rod, the service to be performed in respect of them, in fact, the whole nature of the tenure; take our armorial bearings, for which we have no longer shields, and our crests, for which we have no longer helmets; and to realize their full meaning we must carry our minds back through centuries. Take, again, many of our festive customs, which can be traced back to heathen times; our belief in witches (excusable, perhaps, in Lancashire), our trust in omens, and in lucky and unlucky days, and we see how many of our hereditary prepossessions are derived from a simpler stage of culture. But if this be so now, the same must have held good in earlier days, and the simplest creeds and lowest mental conditions that we meet with in historical times would seem to be but derivatives from something simpler and lower still."

ETHNOLOGY AND ANTHROPOLOGY.

Mr. W. Boyd Dawkins, at the meeting of the British Association, made a report on the exploration of the Victoria Cave, at Settle, Yorkshire. Although the cave was discovered on the day of the Queen's coronation, no systematic investigation was made until the spring of the present year, when a committee, under the chairmanship of Sir James Kay Shuttleworth, commenced the labor. In the upper strata there were found numerous traces of occupation of the cave. Among these were traces of the hog, the sheep, and the horse, and there was also evidence, in the form of 2 "spurs," of the use of the domestic fowl. There were also traces of the reindeer, the badger, and other wild animals, which went to show that the inhabitants of the cave, like the gypsies of the present day, used some of these animals now regarded as vermin as food. There were also 2 Roman coins found, one a Trajan, and one a Tetrarchus, the ivory boss of a sword, some beautiful brooches, amulets, and bronze rings. The discovery of the coins and some articles of the Sarnian pottery, and the domestic fowl (which was introduced by the Romans), seemed to show that this particular occupation of the cave occurred after the Roman period; and he believed it likely that the inhabitants were Roman colonists, who were obliged to flee before the advance of the exterminating Angles and Saxons. In a lower stratum of deposits, separated from the Roman stratum by a talus of about 7 feet, were found a bone harpoon, and remains of the horse and red deer. He would not hazard any theory as to the period of the early occupation thus indicated, but a conjecture might be made on this foundation. The talus of 2 feet which covered the Roman strata might be taken as representing 1,200 years of accumulation; and if the talus between the Roman and the earlier deposit accumulated at the same rate, the period of the deposit might be fixed at between 5,000 and 6,000 years ago. This calculation might, however, be disturbed by various climatic influences, which might hasten or extend the period of the accumulation of the 7 feet talus. There was yet a third layer, in which no human remains, or remains of cattle, had been found, but this part of the investigation had not yet been completed.

Professor Bush threw some doubt on Mr. Dawkins' calculation as to the date of the early occupation of the cave, and suggested that the upper talus, instead of increasing in thickness, had actually been partly cleared away by the action of the weather.

After some remarks by Mr. J. Plant, Manchester, Sir John Lubbock replies to Professor Bush, contending that the climatic influences prevailing in the locality since the time of the Romans could not have been such as to diminish the upper talus. He thought, however, Mr. Dawkins' calculation could not be trusted, because, although the date of his coins could be fixed, there was no evidence to show at what time they were imbedded. He also thought it exceedingly likely that the lower talus had been deposited much more rapidly than the upper talus, inasmuch as the action of the weather was very much more rapid during the first few centuries of the exposure of rocks, and the surface roughnesses fell in much greater quantity than after they became smooth and weather-worn.

HARBORS OF INDIA.

Captain Taylor, late of the Royal Indian Navy, at the meeting of the British Association, communicated a paper on "The Harbors of India." He pointed out that the opening of the Suez Canal made it more than ever important that the harbors of India should be carefully surveyed and improved, especially in the neighborhood of the cotton-growing districts. Kurrachee he considered the Port Said of India, and the government should carry out promptly certain improvements required to make it safe and practicable. Poshetra and Seraia were sheltered from all winds, and capable of receiving even the Great Eastern at any state of the tide. They require lights and beacons. Several ports in the Gulf of Cambay required improvement to render them suitable for the shipment of cotton. Wet docks were wanted at Bombay. Southwards of Bombay were places very suitable for harbors. Canals should also be constructed to connect the various rivers along the eastern coast. In conclusion, Captain Taylor held that *everybody* in England was personally and deeply interested in the *development* of the resources of India by means of improved harbors, roads, rivers, and canals, and that in a poor country, as India now comparatively was, the rapid formation of a general system of cheap transit was the grand desideratum.

THE PHYSICAL GEOGRAPHY OF THE UNITED STATES.

Mr. Robert T. Saunders read a paper at the meeting of the British Association, "On the Physical Geography of the United States of America as affecting Agriculture, with Suggestions for the Increase of the Production of Cotton." After referring to the portions of America which were unfitted for cultivation, and dwelling upon the mineral resources of the country, he remarked that, 6 months ago, after the cotton report of the Memphis Convention was written, 50,000 freedmen left the uplands of Virginia, North Carolina, and Georgia, and went principally to the cotton-fields of the Mississippi River, where they largely contributed to the saving of the last cotton crop, which amounted to 3,000,000 bales. After all, he could not but think that the whole future cotton-supply question depended upon the production of the Southern States of America; and he reminded his hearers that China, Brazil, Peru, the West Indies, Egypt, Turkey, and the Levant did not produce sufficient cotton for their own consumption. No little of the wealth of England had been built up by the cotton States of America; and cheap supplies of raw cotton could still be furnished by those States for the whole world if they could only obtain sufficient labor. It was frequently asked by Europeans whether white men could labor under a summer sun in the Southern States. His answer was that white men labored with remarkable success in midsummer in the Northern States, where the heat was greater and the days longer than in the South. What, therefore, was to prevent them laboring in the South, where there was less heat, and the days were shorter, and where there was more of refreshing coolness in the nights? Besides, one-fourth of the laborers employed in the cotton States were white men.

OBITUARY

OF MEN EMINENT IN SCIENCE. 1870.

Beriot de, Charles August, æt. 62.
Bischoff, G., German Scientist.
Bolly, Prof., A. P., German Chemist, æt. 58.
Chauvenet, Wm., American Mathematician, Dec. 13, æt. 51.
Clark, Sir James, English Physician, June 29, æt. 82.
Colburn, Zerah, American Engineer, April 25, æt. 38.
Dahlgren, John A., Rear Admiral, Inventor, July 12, æt. 65.
Ericsson, Nils, Swedish Engineer, æt. 68.
Geraud, Jacob P., Jr., American Ornithologist, July 19, æt. 59.
Graefe, Albrecht von, German Physician, æt. 45.
Haliday, A. H., Irish Entomologist, July 13.
Hugel, Baron Charles, Austrian Scientist, æt. 75.
Jones, Rev. George, U. S. N., American Scientist, Jan. 22.
Magnus, Heinrich Gustav, German Physicist, April 4, æt. 68.
Matthiessen Augustus, M.D., English Chemist.
Mercadante, Saverio, Italian Composer, æt. 73.
Miller, Prof. William Allen, English Chemist, æt. 53.
Niepce de, Saint Victor, French Photographist, æt. 72.
Otto, Fred Julius, German Chemist, Jan. 12, æt. 61.
Simpson, Sir James, English Physician, May 8, æt. 59.
Unger, Franz, Austrian Botanist, Feb. 13, æt. 70.
Waller, Augustus, M.D.,F.R.S., English Physiologist.

AMERICAN SCIENTIFIC BIBLIOGRAPHY.

Adams, W. H. D. Lighthouses and Lightships. Charles Scribner & Co

Allen, Dr. N. Population, its Law of Increase. Swd. Lowell.

Annual Report of the Trustees of the Museum of Comparative Zoölogy, at Harvard College. 42 pp. 8vo. Boston, 1870.

Bibliography of the Paris Universal Exposition of 1867; by Wm. P. Blake. 40 pp. 8vo.

Chauvenet, Prof. W. Treatise on Elementary Geometry. J. B. Lippincott & Co.

Cooke, Prof. J. P. First Principles of Chemical Philosophy. Sever, Francis & Co., Cambridge.

Cyclopædia of Quantitative Chemical Analysis, Part I. Prof. Frank H. Storer. Sever, Francis & Co., Boston and Cambridge, 1870.

Half-yearly Abstract of the Medical Sciences. Jan., 1870. Swd. H. C. Lea.

Hand-book of Medical Microscopy. Joseph G. Richardson, M.D. pp. 333. 12mo. Phil., J. B. Lippincott & Co., 1870.

Holmes, Prof. F. S. Phosphate Rocks of South Carolina. Charleston.

Lidell, Dr. J. A., and Hamilton, Prof. F. H. Surgical Memoirs of the War of the Rebellion. Hurd & Houghton.

Monograph of the North American Astacidæ; by Dr. H. A. Hagen. Cambridge, 1870.

Ore Deposits, a Treatise on; by Bernhard von Cotta. Translated by Frederick Prime, Jr. 594 pp. 8vo. New York, Van Nostrand, 1870.

Paris Universal Exposition. Extracts from the Report of the International Committee on Weights, Measures, and Coins, with a Notice of the Use of the Metric System in the United States, and its Relations to other Systems of Weights and Measures.

Preliminary Report on the Crustacea dredged in the Gulf Stream in the Straits of Florida; by L. F. de Pourtales. Cambridge, 1870.

Proceedings and Communications of the Essex Institute. Vol. VI. Part I., 1868. Salem.

Proceedings of the Third Annual Convention of Am. Inst. of Architects, New York, 1869. Swd. Western & Co.

Quantitative Chem. Anal., a Series of Instruction in; by Dr. C. R. Fresenius. Edited by Prof. S. W. Johnson. 8vo, pp. 631. New York. John Wiley & Son, 1870.

Report of the Superintendent of the U. S. Coast Survey, showing the Progress of the Survey during the Year 1867. 344 pp., 4to, with 28 maps.

Report of the American Museum of Natural History (Museum in New York Park). 30 pp. 8vo, 1870.

Report of the Bureau of Statistics of Labor. Aug., 1869, March, 1870, Boston.

Report on Education, by John W. Hoyt, U. S. Commissioner to the Paris Universal Exposition. 1870. Government Printing Office, Washington.

Report on Clothing and Woven Fabrics; being Classes twenty-seven to thirty-nine of group four; by Paran Stevens, U. S. Commissioner. 86 pp., 8vo.

Roasting of Gold and Silver Ores, and Extraction of their respective Metals without Quicksilver; by G. Kustel. 154 pp. 12mo. San Francisco, 1870. Dewey & Co.

Robinson, J. R. Explosion of Steam Boilers. Little, Brown & Co.

Share, Dr. J. The Differential Calculus. Bradley, Dayton & Co.

Storer, Frank H. Cyclopædia of Quantitative Analysis. Sever & Francis, Cambridge, 1870.

Tables for the Determination of Minerals; by Thomas Egleston, Jr., Prof. Min. and Met. in the School of Mines, Columbia Coll. 26 pp. 8vo. N. Y., 1870.

Text-book of Elementary Chemistry, Theoretical and Inorganic. Prof. George F. Barker, New Haven, Conn., 1870.

The Andes and the Amazon; or, Across the Continent of South America. Prof James Orton. 356 pp. 12mo. N. Y., 1870. Harper & Bro.

Transactions of the Conn. Academy of Arts and Sciences. Vol. II., Part I. New Haven, 1870.

Trowbridge, J. Annual of Scientific Discovery for 1870. Gould & Lincoln

Upton, Maj. Gen. E. Tactics for Non-Military Bodies. D. Appleton & Co.

Waring, G. E., Jr. Earth Closets and Earth Sewage. N. Y. Tribune Office.

INDEX.

PAGE
Abyssinian geology..................226
Action of chlorine on alcohol........209
" " " " sodium........203
" " light on sulphur 165
" " ozone on explosives 202
" " sulphur on gold............202
Actinism at different altitudes.......145
Address, Mr. Bentham's.............264
Aero-steam engines.................. 31
Africa, diamond fields of.............227
" stone implements of..........333
African exploration..................318
Age of the Wealden..................250
Ague poison..........................301
Air in tissues 271
" salt in the...................... 317
Album, icono-photograph............284
Alcohol, action, on the body, of......280
Alizarine 182
Alkaline lakes of California.........254
Alloy of zinc and calcium............199
Alloys of manganese.................200
Amazon, valley of...................243
American hemp in medicine, value of..............................286
Ammonia, detection of...............173
Amylic alcohol.......................210
Ammonium-amalgam................164
Anæsthetics 270
Animal mechanics, some elementary principles..........................298
Anthropology, Mr. Evans on.........335
" and ethnology.........339
Antiseptic, new......................285
Anthracene, preparation of..........198
Antiseptic treatment of rinderpest and scarlet fever...................275
Antozone.............................162
Arms, new........................... 91
Arsenic, detection of.................204
Arsenic...............................204
Artificial stone, Sorel process......... 70
" leather 113
" horizon......................314
" fruit-odors...................209
Asbestus and corundum.............254
Asphalte tubes for underground lines.................................88
Asteroid, new........................315
Astronomical prize..................315
" Society, the Royal...309
Atomic theory.......................192
Atoms, size of........................127
Atlantic telegraph cables, experiments on 155
Atmosphere, spectrum of the solar..309
Atmospheric ozone..................295
Australian corals.....................252
" mud-fish, the new........296
" tertiary deposits.........224
Axles, *railway*....................... 38

PAGE
Bathybius, distribution of 218
Benzile, optical properties of........151
Bessemer process, chemistry of......177
Bibliography, American............. 34
Birds and small animals, preparation of..............................303
Bentham's address..................264
Bismuth, Peruvian...................200
Bisulphide of carbon.................203
Bleaching fatty oils...................208
" sugar.......................206
Blindness, color... 151
Borax in glass manufacture..........106
Borer, the 274
Boron, heat of combination..........181
Brazilian geology.....................246
Brain, the 270
Breath, human, in health and disease.............. 268
Bridge, concrete and iron............ 47
" over Dnieper.................. 47
" suspension at Pittsburgh, Pa.49
British fossil corals...................251
Broadway underground railway..... 48
Bromhydric acid.................... 199
Bromide of sodium...................198
Bronze, working of...................117
Building material, zinc as 108
Bunsen lamp, flame of...............176

Cable between England and France 86
Cables, Atlantic telegraph, experiments on..........................155
Cable system of river navigation in Germany 83
Calorimetry, use of electric current in....................................139
Calcium lights, use of at St. Louis bridge 104
Cane sugar in madder 203
Canal, Suez.......................... 73
" Darien......................... 72
Capillaries, relation of pigment cells to......................................280
" Captain," construction of the..... 82
" Captain," the...................... 81
Carbonic acid, physiological effects of.....................................287
Caribbean series of Trinidad........248
Carbonic acid, reduction of 209
Cast-iron water-pipes,preservation of 67
Cauterization, use of electricity in..270
Cement, glycerine....................107
Changes of level in Mediterranean..249
Chassepot and needle-gun.......... 88
Chemistry of Bessemer process......177
Chemical geogeny of silica. 196
" climatology................189
Chinese gold-lacker 107
" bronze, malleable properties of...................................107

Chloral, secondary products of manufacture of..................197, 199
Chlorine, action on alcohol.........209
Chloride of gold....................201
Chlorine, manufacture of...........166
Chlorophyll, movements of..........289
Circulation of the culex............291
Claudet's silver process............170
Coal and smoke consumption....... 31
" gas, purification of............173
" mines, ventilation of..........115
Coating for outside walls........... 68
Coleoptera, Plateau on the flight of.272
Colorado, mauvaises terres in......240
" gold and silver mines of...241
Color-blindness....................151
Coccoliths, distribution of...........218
Comet, the light of Winnecke's.... 315
Comets, new.......................316
Combination of sulphur and hydrogen..............................203
Combinations of silicon.............193
Combing flax........................112
Comparative effects of gunpowder and gun cotton 97
Concrete from gas lime............. 66
" and iron bridge........... 47
Condition of carbon and silicon in iron and steel....................176
Condensation of nitrous vapors.....206
Continuity of the gaseous and liquid states of matter..................128
Converter, high pressure........... 119
Copper, estimation of..............204
Coral, Australian genus...........252
Core, flint flake...................334
Corrosion of iron water-pipes.......118
" " gas and water mains........................... 58
Cotton seed fibrous................123
Cross-fertilization and law of sex in Euphorbia.......................288

Darien canal survey................ 72
Darwinian theory of natural selection.......265
Davis refrigerator car 125
Dawson on Laurentian graphite....228
Deacon's chlorine process...........169
Deep-sea thermometers.............137
" dredgings..................212
Descent of glaciers..................220
Detection of ammonia...............173
Determination of sulphur in coal gas 173
Dextrine, insoluble in water 206
Diffusion, application of, in sugar refineries..........................102
Discrimination of mixed fibres......206
Distribution of coccoliths...........218
" of marine life..........216
Diamond fields of South Africa.....227
" in Bohemia..............222
" in Brazil..................247
Dnieper, bridge over................ 47
Drawings, fixing....................124
Drills, recent improvements in...... 60
Dualin............................. 96
Dye, new...........................122

Earthquake-proof church...........116
Eclipse expedition..................xv
Effects of compressed air............281

Efficiency of furnaces and mechanical firing........................... 26
Electrical discharge.................154
Electric current, use of in calorimetry...........................139
Electricity, use of in cauterization..270
Elevation, modern instances of.....250
Embroidery, pentographic..........111
Enamelling iron and steel, improvement in.......................... 55
Engine, Fairlie..................... 36
Engines, friction of steam........... 32
" aero-steam 31
" elastic tires for traction.... 38
" pumping.................... 38
Engineering, the use of wire rope in civil and mechanical.............. 40
Enrichment of gas..................173
Equilateral drawing board 123
Estimation of copper...............204
Ethnology and anthropology........339
Existing coral of palæozoic type....252
Extraction of silver.................170
Explosive power of nitro-glycerine.. 95
Expedition, Sir Samuel Baker's.....328
Extract from the report of Col. W. A. Roebling, chief engineer of the N. Y. Bridge Co.................. 43
Evans on anthropology.............335
Euphorbia, cross fertilization and laws of sex in....................288

Farmer's theorem...................175
Fairlie engine 36
Fertilization of flowers by insects...288
" cross, and law of sex in Euphorbia...........288
Fibrous cotton seed.................123
Fish, volcano.......................300
Fishes, changes in..................300
Fizeau's experiments on Newton's rings...............................151
Flax, combing......................111
Flint flake core.....................334
Flushing sewers....................112
Forbes, utilization of sewage.......187
Forgings, improved appliances for, production of.................... 57
Formation of limestone.............214
Fossils of Nevada..................252
Fossil tooth from Table Mountain..253
Friction of steam engines........... 32
" light.......................112
Fruit trees, girdling to make them bear..................................290
Fungus, intoxicating................292
Furnaces and mechanical firing..... 36
" rotary puddling........... 49
Fusing irodosmine..................201

Gas lime, concrete from............. 66
" enrichment of.................173
" heat by means of.............. 64
" influence of carbonic acid in....175
" McCracken's process...........172
" purification of.................173
Galvanic battery, new..............154
Gelatine, magic lantern pictures on.119
Generation spontaneous............266
Geology of Amazonian valley.......243
Geography of United States.........341
" progress in..............xx

Girdling fruit-trees..................290
Glaciers of the White Mountains...231
“ thickness of...............219
“ descent of................220
Glass manufacture, use of borax in.106
Glycerine cement...................107
Gold................................205
“ in Scotland................... 251
“ detection of.....................205
“ and silver mines of Colorado..241
Gold-lacker, Chinese...............107
“ “ grape sugar.............205
Grafting, skin.......................284
Grape sugar, estimation of 205
Graphite in Laurentian rocks.......228
Great lakes, geology of..............237
Green glass for dark room of photographers...........................122
Guattari atmospheric telegraph..... 84
Gunpowder and gun-cotton, comparative effects of.................. 97
Gun-cotton *vs.* gunpowder........... 97
Gunnery experiments................118

Hackling long vegetable fibres......112
Harbors of India.....................340
Hargreaves, chlorine process........169
“ utilization of phosphorus in furnace slag...205
Heat radiated at low temperatures..138
“ 136
“ by means of illuminating gas 64
“ evolved by invertebrate animals, especially insects......272
“ of combination of boron and silicon.......................181
High pressure converter............119
Hoosac tunnel....................76, 77
Horizon, artificial....................314
Hot-house, imperishable.............120
Human breath in health and disease 268
Hunt, Dr., on iron sand ores........233
Hydrogenium-amalgam..............163
Hydroxylamine, synthesis of.........209

Ice, artificial and natural............ 99
“ machine, Tellier................. 99
“ sudden breaking up of..........142
Icono-photograph album............284
India, harbors of.....................340
Influence of carbonic acid on coal gas 175
“ of ozone on explosives....202
“ “ “ picrates.......202
Insect destructive to the silk culture 274
Insects, fertilization of flowers by...288
“ imported and native American.........................292
“ heat evolved by invertebrate animals, especially.........272
Insoluble dextrine...................206
International communication....... 77
Intoxicating fungus..................292
Invention abroad.....................109
Inventions, new......................121
Iodine, manufacture of...............199
Iron and hydrogen...................200
“ and steel, improvement in enamelling......................... 55
“ manufacture of Russian sheet.. 29
“ native............................255
“ sand ores........................233
“ shafts, cutting up large........118

Iron ships............................117
“ transformation of cast.......... 54
“ water pipe, corrosion of.......118
Irodosmine, fusing..................201
Isometrical drawing board..........123

Jargonium...........................166

Kansas and Missouri bridge........ 51
Kent's cavern.........................251
Kryptophanic acid...................209

Laurentian graphite of Canada.....228
“ rocks of Eastern Massachusetts.................230
Lattice girders and solid plates..... 52
Lead, native..........................255
“ in wine........................165
Leather, artificial....................113
Lignite in Italy.......................250
Limestone, formation of............215
Lightning rods, Prof. Henry on.... 86
Light, the oxygen...................103
Lighthouse apparatus...............117
Limestones, living organisms in....271
Lithofracteur........................ 96
Locality of asbestus.................254
Lockyer's report on eclipse.......XVIII
Logwood in wine, detection of......205
“ in wines..................205

Mains, corrosion of iron, gas, and water............................. 58
Magnesium as reducing agent......201
Man and the man-apes 297
Manganese, alloys of................200
Manufacture of iodine...............199
“ of chlorine............166
Magic lantern pictures on gelatine..119
Machines for preparing Rhea grass..104
Matrix of gold in Scotland..........251
McCracken gas process.............172
Mauvaises terres in Colorado.......240
Mechanical stoking................. 23
Mechanics, animal...................298
Mechanical movement, novel.......124
Medicine, value of American hemp in 286
Meissner, researches on antozone...162
Metallic fastenings of ships, action of sea water on...................... 79
Meteorological.......................316
Microscopic photography...........147
Modern instances of elevation......250
Mordant, oxide of zinc as............208
“ new 208
Mont Cenis tunnel...................117
Movements of chlorophyll...........289
Murchison's address, Sir Roderick..318
Mud-fish, the new Australian.......296

Naphthaline red.....................207
Native iron and lead.................255
Needle-gun.......................... 91
“ chassepot and........... 88
New arms........................... 91
“ Australian mud-fish............296
“ antiseptic........................265
“ asteroid 315
“ Cambridge transit instrument..314
“ comets..........................316
“ dye 122
“ inventions......................121

New observatory......................312
" sphygmoscope......................306
" spectroscope......................305
" theory of sleep......................296
Neocomian of North America........223
Nevada, fossils of......................252
Newton's rings, Fizeau's experiments on 151
Nickel plating......................105
Nitro-glycerine, explosive power of 95
Non-luminosity of Bunsen flame 176
Novel mechanical movement.........124

Oat husks, paper from................120
Obituary of men eminent in science 342
Ocean telegraphy...................... 87
Ooze from Atlantic sea-bed..........214
Optical properties of benzile.........151
Organic matter of human breath in health and disease..................269
Organisms in limestone, living 271
Organic compounds of silica.........195
Oxide of zinc as mordant............208
Oxygen light......................103
Ozone, atmospheric......................295
" influence on picrates..........202

Paper from oat husks................120
Paving streets......................111
Pentagraphic embroidery............111
Peruvian bismuth......................200
Petroleum for heating locomotive boilers......................116
Phenyl brown 207
Photographing the sun..............308
Photographers' dark room, green glass for......................122
Photography applied to military purposes.................. 91
" and molecular physics.147
" microscopic.............147
" on wood................102
Phosphate-beds of South Carolina... 234
Phosphoric acid from furnace slag.. .205
Phosphorescence......................211
Physiological effects of carbonic acid 287
Physiology of fats......................301
Piles, sinking screw.................. 53
Plateau on the flight of coleopotera.272
Platinum in Lapland..................251
Plating, nickel......................105
Poison, ague......................301
" snake......................302
Polishing powder for glass and metal...................... 99
Post-tertiary phenomena in Michigan......................239
Potassium and iron, sulphide of....199
Preparation of anthracene...........198
" " birds and small animals................303
" " bromide of sodium..198
" " bromhydric acid....199
" " strontium............199
Preservation of meat.................126
" " stones............68, 69
" " thallium. 200
Preserved flesh in Australia..........126
Prize, astronomical....................315
Prof. Tyndall......................267
Progress of invention abroad.........109
Projectiles...................... 90
Protuberances, solar....................311
Prussian needle-gun.............. 91
Pulse-beats......................271
Pump, new rotary.................. 65
Purification of bisulphide of carbon.203
Pyrometer, resistance................156

Railway axles...................... 38
" Broadway underground.... 48
" steep...................... 49
Reagent for strychnia 173
" " ammonia 173
Reduction of isatine to Indigo-blue..221
" " carbonic acid. 209
Refraction and dispersion of opaque bodies......................143
Relation of light produced to gas consumed......................174
Resistance pyrometer..................154
Rhea grass, machines for preparing.104
Rinderpest and scarlet fever, antiseptic treatment of......................275
Rio Grande, valley of..................243
River pollution............. 184
Roebling, Col. W. A.................. 43
Rotary puddling furnaces............ 49
" pump, new...................... 65
Royal Albert Hall of arts and sciences, ventilation of........... 62
" Astronomical Society..........309
Russia sheet iron, manufacture of... 29

Sailing, windward great circle....... 82
Salt in the air......................317
Scarlet fever and rinderpest, antiseptic treatment of......................275
Scotland, gold in......................251
Screw piles, sinking.................. 53
Sea-water, action of on metallic fastenings of ships.................. 79
Sewers, Flushing......................112
Shaler, on phosphate beds in So. Carolina......................234
Ships, iron......................117
Silver ore in India......................252
" extraction of....................170
Silica, geogony of......................196
Silico-propionic acid..................195
Silicon, heat of combination.........181
Silk culture,insect destructive to the 274
Single rail tramway....................115
Sir Samuel Baker's expedition.......328
Skin grafting......................284
Slag......................116
Sleep, new theory of....................296
Smith, Angus, on chemical climatology......................189
Smoke and coal consumption....... 31
Snake poison......................302
Sodium as a flux......................202
Solar protuberances....................311
Solar spots......................309
Solid, bisulphide of carbon 203
Solubility of sulphate of lead........165
Sorel process...................... 70
Sound, velocity of......................134
Southern hemisphere, new observatory in the......................312
Spectrum of the solar atmosphere..309
" " a " prominence..311
Spectroscope, new......................305

Sphygmoscope, new.................286
Spontaneous generation.............266
Statistics of soda manufacture......170
Steam hammer, an eight-ton........118
" boilers.........................112
Steering gear 110
Stone implements of Western Africa 333
Stones, preservation of.............68,69
St. Louis bridge, effects of compressed air on men employed on..281
Stoking, mechanical................. 23
Street-paving.........................111
Storms announced by telegraph.....316
Strontium, preparation of...........199
Strychnia.............................173
" reagent for.................205
Submergence of American continent................................254
Sublimation of sesquichloride of gold 201
Suez canal........................... 73
Sugar refineries, diffusion in.........102
" refining process...............101
Sulphate of lead, solubility of........165
Sulphur, action of light on...........165
" in coal gas, estimation of..173
Sulphuretted hydrogen, formation of.203
Sun, photographing the.............308
Supersaturation......................133
Surface geology of basin of Great Lakes..............................237
Survey of Isthmus of Darien......... 74
Suspension bridge at Pittsburg, Pa. 46
Synthesis of indigo..................211
" " hydroxylamine.........209

Tertiary deposits of Australia......224
Telegraph, storms announced by....316
" Guattari atmospheric... 84
Telegraphy, ocean.................... 87
Tellier ice-machine.................. 99
Thames, new tunnel under.......... 50
Thallium, preservation of...........200
Thermometers, deep sea............137
Thickness of glaciers................219
Tissues, air in.......................271
Traction engine, elastic tires for.... 38
Tramway, single rail.................115
Tramway, wire rope................. 40
Transformation of cast iron......... 54
Transportation of fresh meats and fruits..............................125
Transformation of fatty acids into alcohols..............................210
Transit instrument, the new Cambridge...............................314
Trinkerite 203
Tunnel, Hoosac, central shaft 76
" Mont Cenis..................117
" under the Thames........... 50
Twist drills, recent improvements in 60
Tyndall, Prof.........................267

Underground lines, asphalte tubes for.................... 88
" railway, Broadway.... 48
United States, physical geography of 341
Utilization of sewage................187
" " waste nitrous fumes..206
Utilizing waste threads.............111

Valley of the Rio Grande............243
" " Amazon................243
Velocity of sound....................134
Ventilation of coal mines...........115
" " Royal Albert hall of arts and sciences... 62
Volcano fish.........................300
Volumetric estimation of copper....204
Vowel sounds, fixed notes characteristic of.............................135

Walls, coating for outside...........68
Watering streets by chemicals......109
Water pipes, preservation of cast iron................................ 67
Wealden, age of 250
Weldon's chlorine proof............166
White Mountains, geology of.......230
" " glaciers of.......231
Windward great-circle sailing....... 82
Window, new........................122
Winnecke's comet, light of..........315
Wire rope tramway at Brighton, Eng................................ 40
Wood, photography on.............102

Young, Prof., report on eclipse.....XVI

Zinc and calcium, alloy of........ ..199
" as a building material..........108
Zöllner, Prof.........................XII

Valuable Works,

PUBLISHED BY

GOULD AND LINCOLN,

59 Washington Street, Boston.

HAMILTON'S LECTURES, embracing the Metaphysical and Logical Courses; with Notes, from Original Materials, and an Appendix, containing the Author's Latest Development of his New Logical Theory. Edited by Rev. Henry Longueville Mansel, B. D., Prof. of Moral and Metaphysical Philosophy in Magdalen College, Oxford, and John Veitch, M. A., of Edinburgh. In two royal octavo volumes, viz.,

I. Metaphysical Lectures. Royal octavo, cloth, 3.50.

II. Logical Lectures. Royal octavo, cloth, 3.50.

☞ G. & L., by a special arrangement with the family of the late Sir William Hamilton, are the authorized, and only authorized, American publishers of this distinguished author's *matchless* Lectures on Metaphysics and Logic.

The above have already been introduced into nearly all our leading colleges.

LOOMIS' ELEMENTS OF GEOLOGY; adapted to Schools and Colleges. With numerous Illustrations. By J. R. Loomis, President of Lewisburg University, Pa. 12mo, cloth, 1.25.

"It is surpassed by no work before the American public." — *M. B. Anderson, LL. D., President Rochester University.*

PEABODY'S CHRISTIANITY THE RELIGION OF NATURE. Lectures delivered before the Lowell Institute in 1863, by A. P. Peabody, D. D., LL. D., Preacher to the University, and Plummer Professor of Christian Morals, Harvard College. Royal 12mo, cloth, 1.50.

A masterly production, distinguished for its acuteness and earnestness, its force of logic and fairness of statement, written in a style of singular accuracy and beauty.

PALEY'S NATURAL THEOLOGY: Illustrated by forty Plates, with Selections from the Notes of Dr. Paxton, and Additional Notes, Original and Selected, with a Vocabulary of Scientific Terms. Edited by John Ware, M. D. Improved edition, with elegant illustrations. 12mo, cloth, embossed, 1.75.

MANSEL'S PROLEGOMENA LOGICA; the Psychological Character of Logical Processes. By Henry Longueville Mansel, B. D. 12mo, cloth, 1.25.

YOUNG LADIES' CLASS BOOK: a Selection of Lessons for Reading in Prose and Verse. By Ebenezer Bailey, A. M. Cloth, embossed, 1.25.

HAVEN'S MENTAL PHILOSOPHY; Including the Intellect, the Sensibilities, and the Will. By JOSEPH HAVEN, Professor of Intellectual and Moral Philosophy, Chicago University. Royal 12mo, cloth, embossed, 2.00.

It is believed this work will be found preëminently distinguished for the COMPLETENESS with which it presents the whole subject.

HAVEN'S MORAL PHILOSOPHY: Including Theoretical and Practical Ethics. By JOSEPH HAVEN, D. D., late Professor of Moral and Intellectual Philosophy in Chicago University. Royal 12mo, cloth, embossed, 1.75.

It is eminently scientific in method, and thorough in discussion, and its views on unsettled questions in morals are discriminating and sound.

HOPKINS' LECTURES ON MORAL SCIENCE, delivered before the Lowell Institute, Boston, by MARK HOPKINS, D. D., President of Williams College. Royal 12mo, cloth, 1.50.

☞ An important work from the pen of one of the most profound thinkers of the age.

WAYLAND'S ELEMENTS OF MORAL SCIENCE. By FRANCIS WAYLAND, D. D., late President of Brown University. 12mo, cloth, 1.75.

WAYLAND'S MORAL SCIENCE ABRIDGED, and adapted to the use of Schools and Academies, by the Author. Half mor., 70 cts.

The same, CHEAP SCHOOL EDITION, boards, 45 cts.

WAYLAND'S ELEMENTS OF POLITICAL ECONOMY. By FRANCIS WAYLAND, D. D. 12mo, cloth, 1.75.

WAYLAND'S POLITICAL ECONOMY ABRIDGED, and adapted to the use of Schools and Academies, by the Author. Half mor., 70 cents.

All the above works by Dr. Wayland are used as text-books in most of the colleges and higher schools throughout the Union, and are highly approved.

AGASSIZ AND GOULD'S PRINCIPLES OF ZOÖLOGY; Touching the Structure, Development, Distribution, and Natural Arrangement, of the RACES OF ANIMALS, living and extinct, with numerous Illustrations. For the use of Schools and Colleges. Part I. COMPARATIVE PHYSIOLOGY. By LOUIS AGASSIZ and AUGUSTUS A. GOULD. Revised edition. 1.50.

PART II. Systematic Zoölogy. *In preparation.*

"It is simple and elementary in its style, full in its illustrations, comprehensive in its range, yet well condensed, and brought into the narrow compass requisite for the purpose intended." — *Silliman's Journal.*

RITTER'S GEOGRAPHICAL STUDIES. Translated from the German of Carl Ritter, by Rev. W. L. GAGE. With a Sketch of the Author's Life, and a Portrait. 12mo, cloth, 1.50.

This volume contains the grand generalizations of Ritter's life-work, the Erdkünde, in eighteen volumes; his lectures on the Relations of Geography and History, and a number of important papers on Physical Geography.

PROGRESSIVE PENMANSHIP, Plain and ornamental, for the use of Schools. By N. D. GOULD, author of "Beauties of Writing," "Writing Master's Assistant," etc. In five parts, each, 20 cts.

ROGET'S THESAURUS OF ENGLISH WORDS AND PHRASES, so classified and arranged as to facilitate the expression of ideas, and assist in literary composition. New and improved edition. By PETER MARK ROGET, late Secretary of the Royal Society, London, etc. Revised and edited, with a List of Foreign Words defined in English, and other additions, by BARNAS SEARS, D. D., President of Brown University. A NEW AMERICAN Edition, with ADDITIONS AND IMPROVEMENTS. 12mo, cloth, 2.00.

The first American edition having been prepared by Prof. Sears for *strictly educational purposes*, those words and phrases properly termed "vulgar," incorporated in the original work, were omitted. These expurgated portions have, in the present edition, been *restored*, but by such an arrangement of the matter as not to interfere with the educational purposes of the American editor. Besides this it contains important additions not in the English edition, of words and phrases, and also an alphabetical list of "FOREIGN WORDS AND PHRASES"—Latin, French, Italian, Spanish, Greek, etc.—which most frequently occur in works of general literature, defined in English, making it in *all respects more full and perfect than the author's edition.*

GUYOT'S EARTH AND MAN; Lectures on COMPARATIVE PHYSICAL GEOGRAPHY, in its relation to the History of Mankind. By ARNOLD GUYOT. With Illustrations. 12mo, cloth, 1.75.

GUYOT'S MURAL MAPS. A series of elegant Colored Maps, projected on a large scale for the Recitation Room, consisting of a Map of the World, North and South America, Geographical Elements, &c., exhibiting the Physical Phenomena of the Globe. By Professor ARNOLD GUYOT, viz.,

GUYOT'S MAP OF THE WORLD, *mounted*, 12.00.

GUYOT'S MAP OF NORTH AMERICA, *mounted*, 11.00.

GUYOT'S MAP OF SOUTH AMERICA, *mounted*, 11.00.

GUYOT'S GEOGRAPHICAL ELEMENTS, *mounted*, 11.00.

☞ These elegant and entirely original Mural Maps are projected on a large scale, so that when suspended in the recitation room they may be seen from any point, and the delineations without difficulty traced distinctly with the eye. They are beautifully printed in colors, and neatly mounted for use.

BARTON'S EASY LESSONS IN ENGLISH GRAMMAR, for Young Beginners. By W. S. BARTON, A. M. 12mo, half mor., 75 cts.

Designed as a SEQUEL TO THE AUTHOR'S NEW SYSTEM OF ENGLISH GRAMMAR, which forms a gradual introduction to the first principles of composition.

BARTON'S NEW INTERMEDIATE SYSTEM OF ENGLISH GRAMMAR. By W. S. BARTON, A. M. 12mo, half mor., 1.00.

BARTON'S PRACTICAL EXERCISES IN ENGLISH COMPOSITION; or, THE YOUNG COMPOSER'S GUIDE. By W. S. BARTON, A. M. 12mo, half mor., 1.00.

BARTON'S HIGH SCHOOL GRAMMAR; or, an Exposition of Grammatical Structure of the English Language. By W. S. BARTON, A. M. 12mo. half mor., 1.50.

The above works by Prof. Barton, designed as text-books for the use of schools and academies, are the result of long experience, and will be found to possess many and peculiar merits.

THE GREYSON LETTERS. Selections from the Correspondence of R. E. H. GREYSON, Esq. Edited by HENRY ROGERS, author of "The Eclipse of Faith." 12mo, cloth, 1.75.

"The Letters are intellectual gems, radiant with beauty, happily intermingling the grave and the gay."—*Christian Observer.*

MASSON'S BRITISH NOVELISTS AND THEIR STYLES. Being a Critical Sketch of the History of British Prose Fiction. By DAVID MASSON, M. A., Author of "The Life and Times of John Milton," &c., &c. 16mo, cloth, 1 75.

HISTORY OF CHURCH MUSIC IN AMERICA. Treating of its peculiarities at different periods; its legitimate use and its abuse; with Criticisms, Cursory Remarks, and Notices, relating to Composers, Teachers, Schools, Choirs, Societies, Conventions, Books, &c. By NATHANIEL D. GOULD, author of "Social Harmony," "Church Harmony," "Sacred Minstrel," &c. 12mo, cloth, 1.00.

THE CAPTIVE IN PATAGONIA; or, Life among the Giants. A Personal Narrative. By BENJAMIN FRANKLIN BOURNE. With Illustrations. 12mo, cloth, 1.25.

A work of thrilling interest, as well as of instruction, to all classes of readers.

THE CRUISE OF THE NORTH STAR; A Narrative of the Excursion made by Mr. Vanderbilt's Party in the Steam Yacht, in her Voyage to England, Russia, Denmark, France, Spain, Italy, Malta, Turkey, Madeira, &c., &c. By Rev. JOHN OVERTON CHOULES, D. D. With elegant Illustrations, &c. 12mo, cloth, gilt back and sides, 2.50.

AMERICAN HISTORIES, BY JOSEPH BANVARD.

Four Volumes. Price $3.60.

PLYMOUTH AND THE PILGRIMS; or, Incidents and Adventures in the History of the first Settlers. With Illustrations. 16mo, cloth, 90 cts.

NOVELTIES OF THE NEW WORLD. An Account of the Adventures and Discoveries of the Explorers of North America. With numerous Illustrations. 16mo, cloth, 90 cts.

ROMANCE OF AMERICAN HISTORY; or, An Account of the Early Settlement of North Carolina and Virginia; embracing Incidents connected with the Spanish Settlements, the French Colonies, and the English Plantation, etc. With Illustrations. 16mo, cloth, 90 cts.

TRAGIC SCENES IN THE HISTORY OF MARYLAND AND THE OLD FRENCH WAR, with an account of various interesting contemporaneous events which occurred in the early settlement of America. With numerous elegant Illustrations. 16mo, cloth, 90 cts.

☞ The above four volumes are bound in uniform style, and put up in a neat, substantial box, price 3.60.

☞ Each volume is complete in itself, and yet together they form a regular series of American Histories.

MILLER'S CRUISE OF THE BETSEY; or, a Summer Ramble among the Fossiliferous Deposits of the Hebrides. With Rambles of a Geologist; or, Ten Thousand Miles over the Fossiliferous Deposits of Scotland. 12mo, pp. 524, cloth, 1.75.

MILLER'S ESSAYS, Historical and Biographical, Political and Social, Literary and Scientific. By HUGH MILLER. With Preface by Peter Bayne. 12mo, cloth, 1.75.

MILLER'S FOOT-PRINTS OF THE CREATOR; or, the Asterolepis of Stromness, with numerous Illustrations. With a Memoir of the Author, by LOUIS AGASSIZ. 12mo, cloth, 1.75.

MILLER'S FIRST IMPRESSIONS OF ENGLAND AND ITS PEOPLE. With a fine Engraving of the Author. 12mo, cloth, 1.50.

MILLER'S HEADSHIP OF CHRIST, and the Rights of the Christian People, a Collection of Personal Portraitures, Historical and Descriptive Sketches and Essays, with the Author's celebrated Letter to Lord Brougham. By HUGH MILLER. Edited, with a Preface, by PETER BAYNE, A. M. 12mo. cloth, 1.75.

MILLER'S OLD RED SANDSTONE; or, New Walks in an Old Field. Illustrated with Plates and Geological Sections. NEW EDITION, REVISED AND MUCH ENLARGED, by the addition of new matter and new Illustrations &c. 12mo, cloth, 1.75.

MILLER'S POPULAR GEOLOGY; With Descriptive Sketches from a Geologist's Portfolio. By HUGH MILLER. With a Resume of the Progress of Geological Science during the last two years. By MRS. MILLER. 12mo, cloth, 1.75.

MILLER'S SCHOOLS AND SCHOOLMASTERS; or, the Story of my Education. AN AUTOBIOGRAPHY. With a full-length Portrait of the Author. 12mo, 1.75.

MILLER'S TALES AND SKETCHES. Edited, with a Preface, &c., by MRS. MILLER. 12mo, 1.50.

Among the subjects are: Recollections of Ferguson — Burns — The Salmon Fisher of Udoll — The Widow of Dunskaith — The Lykewake — Bill Whyte — The Young Surgeon — George Ross, the Scotch Agent — M'Culloch, the Mechanician — A True Story of the Life of a Scotch Merchant of the Eighteenth Century.

MILLER'S TESTIMONY OF THE ROCKS; or, Geology in its Bearings on the two Theologies, Natural and Revealed. "Thou shalt be in league with the stones of the field." — *Job.* With numerous elegant Illustrations One volume, royal 12mo, cloth, 1.75.

HUGH MILLER'S WORKS. Ten volumes, uniform style, in an elegant box, embossed cloth, 17; library sheep, 20; half calf, 34; antique, 34.

MACAULAY ON SCOTLAND. A Critique from HUGH MILLER'S "Witness." 16mo, flexible cloth. 37 cts.

CHAMBERS' CYCLOPÆDIA OF ENGLISH LITERATURE. A Selection of the choicest productions of English Authors, from the earliest to the present time. Connected by a Critical and Biographical History. Forming two large imperial octavo volumes of 700 pages each, double-column letter press; with upwards of three hundred elegant Illustrations. Edited by ROBERT CHAMBERS. Embossed cloth, 6.50; sheep, 7.50; cloth, full gilt, 9.00; half calf, 12.00; full calf, 16.00.

This work embraces about *one thousand Authors*, chronologically arranged, and classed as poets, historians, dramatists, philosophers, metaphysicians, divines, &c., with choice selections from their writings, connected by a Biographical, Historical, and Critical Narrative; thus presenting a complete view of English Literature from the earliest to the present time. Let the reader open where he will, he cannot fail to find matter for profit and delight. The selections are gems—infinite riches in a little room; in the language of another, "A WHOLE ENGLISH LIBRARY FUSED DOWN INTO ONE CHEAP BOOK."

☞ THE AMERICAN edition of this valuable work is enriched by the addition of fine steel and mezzotint engravings of the heads of SHAKSPEARE, ADDISON, BYRON; a full-length portrait of DR. JOHNSON; and a beautiful scenic representation of OLIVER GOLDSMITH and DR. JOHNSON. These important and elegant additions, together with superior paper and binding, and other improvements, render the AMERICAN far superior to the English edition.

CHAMBERS' HOME BOOK; or, Pocket Miscellany, containing a Choice Selection of Interesting and Instructive Reading, for the Old and Young. Six volumes. 16mo, cloth, 6.00; library sheep, 7.00.

ARVINE'S CYCLOPÆDIA OF ANECDOTES OF LITERATURE AND THE FINE ARTS. Containing a copious and choice Selection of Anecdotes of the various forms of Literature, of the Arts, of Architecture, Engravings, Music, Poetry, Painting, and Sculpture, and of the most celebrated Literary Characters and Artists of different Countries and Ages, &c. By KAZLITT ARVINE, A. M., author of "Cyclopædia of Moral and Religious Anecdotes." With numerous illustrations. 725 pp. octavo, cloth, 4.00; sheep, 5.00; cloth, gilt, 6.00; half calf, 7.00.

This is unquestionably the choicest collection of *Anecdotes* ever published. It contains *three thousand and forty Anecdotes:* and such is the wonderful variety, that it will be found an almost inexhaustible fund of interest for every class of readers. The elaborate classification and Indexes must commend it especially to public speakers, to the various classes of *literary and scientific men*, to *artists*, *mechanics*, and *others*, as a DICTIONARY *for reference*, in relation to facts on the numberless subjects and characters introduced. There are also more than *one hundred and fifty fine Illustrations.*

BAYNE'S ESSAYS IN BIOGRAPHY AND CRITICISM. By PETER BAYNE, M. A., author of "The Christian Life, Social and Individual." Arranged in two Series, or Parts. 12mo, cloth, each, 1.75.

These volumes have been prepared and a number of the Essays written by the author expressly for his American publishers.

THE LANDING AT CAPE ANNE; or, THE CHARTER OF THE FIRST PERMANENT COLONY ON THE TERRITORY OF THE MASSACHUSETTS COMPANY. Now discovered, and first published from the ORIGINAL MANUSCRIPT, with an inquiry into its authority, and a HISTORY OF THE COLONY, 1624–1628, Roger Conant, Governor. By J. WINGATE THORNTON. 8vo, cloth, 2.50.

☞ "A rare contribution to the early history of New England."—*Journal.*

ANNUAL OF SCIENTIFIC DISCOVERY FOR 1871; or, Year Book of Facts in Science and Art, exhibiting the most important Discoveries and Improvements in Mechanics, Useful Arts, Natural Philosophy, Chemistry, Astronomy, Meteorology, Zoölogy, Botany, Mineralogy, Geology, Geography, Antiquities, &c., together with a list of recent Scientific Publications; a classified list of Patents; Obituaries of eminent Scientific Men; an Index of Important Papers in Scientific Journals, Reports, &c.

12mo. 2.00.

VOLUMES OF THE SAME WORK for years 1850 to 1870 (twenty vols.), with the Likeness of some distinguished Scientific or Literary man in each. 2.00 per volume.

The whole Series bound in uniform style, and put up in an elegant, substantial box, 40.00.

This work, issued annually, contains all important facts discovered or announced during the year. ☞ Each volume is distinct in itself, and contains *entirely new matter*.

THE PLURALITY OF WORLDS. A NEW EDITION. With a SUPPLEMENTARY DIALOGUE, in which the author's Reviewers are reviewed. 12mo, cloth, 1.50.

THE ROMANCE OF NATURAL HISTORY. By PHILIP HENRY GOSSE. With numerous elegant Illustrations. 12mo, cloth, 1.75.

THE NATURAL HISTORY OF THE HUMAN SPECIES; Its Typical Forms and Primeval Distribution. By CHARLES HAMILTON SMITH. With an Introduction containing an Abstract of the views of Blumenbach, Prichard, Bachman, Agassiz, and other writers of repute. By SAMUEL KNEELAND, Jr., M. D. With elegant Illustrations. 12mo, cloth, 1.75.

TREATISE ON THE COMPARATIVE ANATOMY OF THE ANIMAL KINGDOM. By Profs. C. TH. VON SIEBOLD and H. STANNIUS. Translated from the German, with Notes, Additions, &c. By WALDO I. BURNETT, M. D., Boston. One elegant octavo volume, cloth, 3.50.

This is believed to be incomparably the best and most complete work on the subject extant.

THE CAMEL; His Organization, Habits, and Uses, considered with reference to his introduction into the United States. By GEORGE P. MARSH, late U. S. Minister at Constantinople. 12mo, cloth, 75 cts.

INFLUENCE OF THE HISTORY OF SCIENCE UPON INTELLECTUAL EDUCATION. By WILLIAM WHEWELL, D. D., of Trinity College, England, and the alleged author of "Plurality of Worlds." 12mo, cloth, 40 cts.

KNOWLEDGE IS POWER. A view of the Productive Forces of Modern Society, and the Results of Labor, Capital, and Skill. By CHARLES KNIGHT. With numerous Illustrations. American Edition. Revised, with additions, by DAVID A. WELLS, Editor of the "Annual of Scientific Discovery." 12mo, cloth, 1.75.

GOULD'S MOLLUSCA AND SHELLS. By Augustus A. Gould, M. D. (United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under Charles Wilkes, U. S. N. Vol. XII.) Elegant quarto volume, cloth, net, 10.00.

GOULD'S ATLAS TO MOLLUSCA AND SHELLS. By A. A. Gould, M. D., &c. One volume quarto. Elegant Engravings on stone. In sheets, plain, net, 25.00; in sheets, colored, net, 40.00.

GEOGRAPHICAL DISTRIBUTION OF ANIMALS AND PLANTS. (United States Exploring Expedition; during the years 1838, 1839, 1840, 1841, 1842, under Charles Wilkes, U. S. N. Vol. XV.) By Charles Pickering, M. D., Member of the Scientific Corps attached to the Expedition. One volume quarto, cloth, 4.00.

GOULD'S OTIA CONCHOLOGICA. Descriptions of Shells and Mollusks, from 1839 to 1862. By Augustus A. Gould, M. D. Octavo, cloth, 2.00; stiff paper cover, 1.50.

MODERN FRENCH LITERATURE. By L. Raymond de Vericour. Revised, with Notes, by William S. Chase, A. M. With a fine Portrait of Lamartine. 12mo, cloth, 1.75.

"The only complete treatise on this subject, either in French or English."—*N. Y. Evening Post.*

NOTES ON THE UNITED STATES OF AMERICA. By T. H. Grand Pierre, D. D., Pastor of the Reformed Church, Paris. 16mo, cloth, 65.

SPIRITUALISM TESTED; or, the Facts of its History Classified, and their Cause and Nature Verified from Ancient and Modern Testimonies. By George W. Samson, D.D., President of Columbian College, Washington, D. C. 16mo, cloth, 60.

SPRAGUE'S VISITS TO EUROPEAN CELEBRITIES. By the Rev. William B. Sprague, D. D. 12mo, cloth, 1.50; cloth, gilt, 2.00.

SMITH'S PILGRIMAGE TO EGYPT; embracing a Diary of Explorations on the Nile, with Observations Illustrative of the Manners, Customs, and Institutions of the People, and of the present condition of the Antiquities and Ruins. By Hon. J. V. C. Smith, late Mayor of the City of Boston. With numerous elegant Engravings. 12mo, cloth, 1.75.

THE STORY OF MY CAREER, as Student of Frieberg and Jena, and Professor at Halle, Breslau, and Berlin. With Personal Reminiscences of Goethe, Schiller, Schelling, Schleiermacher, Fichte, Novalis, Schlegel, Neander, and others. By Heinrich Steffens. Translated by William L. Gage 16mo, 1.00.

ANCIENT LITERATURE AND ART. Miscellaneous Essays on subjects connected with classical Literature, with the Biography and Correspondence of eminent Philologists. By Prof. B. Sears, President of Brown University, B. B. Edwards, of Andover, and C. C. Felton, of Cambridge. Second thousand. 12mo, cloth, 1.75.

LIFE, TIMES, AND CORRESPONDENCE OF JAMES MANNING, AND THE EARLY HISTORY OF BROWN UNIVERSITY. By REUBEN ALDRIDGE GUILD. With Likenesses of President Manning and Nicholas Brown, Views of Brown University, The First Baptist Church, Providence, etc., Royal 12mo, cloth, 3.00.

A most important and interesting historical work.

MEMOIR OF GEORGE N. BRIGGS, LL. D., late Governor of Massachusetts. By W. C. RICHARDS. With Illustrations. Royal 12mo. 2.50

THE LIFE OF JOHN MILTON, narrated in connection with the POLITICAL, ECCLESIASTICAL, AND LITERARY HISTORY OF HIS TIME. By DAVID MASSON, M. A., Professor of English Literature, University College, London. Vol. I., embracing the period from 1608 to 1639. With Portraits and specimens of his handwriting at different periods. Royal octavo, cloth, 3.50.

LIFE AND CORRESPONDENCE OF REV. DANIEL WILSON, D. D., late Bishop of Calcutta. By Rev. JOSIAH BATEMAN, M. A., Rector of North Cray, Kent. With Portraits, Map, and numerous Illustrations. One volume royal octavo, cloth, 3.50.

☞ An interesting life of a great and good man.

THE LIFE AND TIMES OF JOHN HUSS; or, The Bohemian Reformation of the Fifteenth Century. By Rev. E. H. GILLETT. Two vols. royal octavo, 7.00.

"The author," says the *New York Observer*, "has achieved a great work, performed a valuable service for Protestantism and the world, made a name for himself among religious historians, and produced a book that will hold a prominent place in the esteem of every religious scholar."

The *New York Evangelist* speaks of it as "one of the most valuable contributions to ecclesiastical history yet made in this country."

MEMOIR OF THE CHRISTIAN LABORS, Pastoral and Philanthropic, of THOMAS CHALMERS, D. D. L.L. D. By FRANCIS WAYLAND 16mo, cloth, 1.00.

The moral and intellectual greatness of Chalmers is, we might say, overwhelming to the mind of the ordinary reader. Dr. Wayland draws the portraiture with a master hand. — Method. Quart. Rev.

LIFE OF JAMES MONTGOMERY. By Mrs. H. C. KNIGHT, author of "Lady Huntington and her Friends," etc. Likeness, and elegant Illustrated Title-Page on steel. 12mo, cloth, 1.50.

DIARY AND CORRESPONDENCE OF AMOS LAWRENCE. With a brief account of some Incidents in his Life. Edited by his son, WM. R. LAWRENCE, M. D. With elegant Portraits of Amos and Abbott Lawrence, an Engraving of their Birthplace, an Autograph page of Handwriting, and a copious Index. One large octavo volume, cloth, 2.50.

THE SAME WORK. Royal 12mo, cloth, 1.75.

DR. GRANT AND THE MOUNTAIN NESTORIANS. By Rev. THOMAS LAURIE, his surviving associate in that Mission. With a Likeness, Map of the Country, and numerous Illustrations. Third edition. Revised and improved. 12mo, cloth, 1.75. ☞ A most valuable memoir of a *remarkable man.*

THE PURITANS; or, The Court, Church, and Parliament of England, during the reigns of Edward VI. and Elizabeth. By SAMUEL HOPKINS, author of Lessons at the Cross," etc. In 3 vols. Octavo, cloth, per vol., 3.00; sheep, 4.00; half calf, 6.00.

It will be found the most interesting and reliable History of the Puritans yet published, narrating in a dramatic style, many facts hitherto unknown.

THE PREACHER AND THE KING; or, Bourdaloue in the Court of Louis XIV.; being an Account of the Pulpit Eloquence of that distinguished era. Translated from the French of L. F. BUNGENER, Paris. Introduction by the Rev. GEORGE POTTS, D. D. *A new, improved edition*, with a fine Likeness and a BIOGRAPHICAL SKETCH OF THE AUTHOR. 12mo, cloth, 1.50.

THE PRIEST AND THE HUGUENOT; or, Persecution in the Age of Louis XV. From the French of L. F. BUNGENER. Two vols. 12mo, cloth, 3.00.

☞ This is not only a work of thrilling interest, — no fiction could exceed it, — but, as a Protestant work, it is a masterly production.

THE PULPIT OF THE AMERICAN REVOLUTION; or, The Political Sermons of the Period of 1776. With an Historical Introduction, Notes, Illustrations, etc. By JOHN WINGATE THORNTON, A. M. 12mo, cloth, 1.75.

THE LEADERS OF THE REFORMATION. LUTHER, CALVIN, LATIMER, and KNOX, the representative men of Germany, France, England, and Scotland. By J. TULLOCH, D. D., Author of "Theism," etc. 12mo, cloth, 1.50.

A portrait gallery of sturdy reformers, drawn by a keen eye and a strong hand. Dr. Tulloch discriminates clearly the personal qualities of each Reformer, and commends and criticises with equal frankness.

THE HAWAIIAN ISLANDS; their Progress and Condition under Missionary Labors. By RUFUS ANDERSON, D. D., Foreign Secretary of the American Board of Commissioners for Foreign Missions. With Maps, Illustrations, etc. Royal 12mo, cloth, 2.25.

WOMAN AND HER SAVIOUR in Persia. By a RETURNED MISSIONARY. With beautiful Illustrations and a Map of the Nestorian Country. 12mo, cloth, 1.25.

LIGHT IN DARKNESS; or, Christ Discerned in his True Character by a Unitarian. 16mo, cloth, 90 cts.

LIMITS OF RELIGIOUS THOUGHT EXAMINED, in Eight Lectures, delivered in the Oxford University Pulpit, in the year 1858, on the "Bampton Foundation." By Reu. H. LONGUEVILLE MANSEL, B. D., Reader in Moral and Metaphysical Philosophy at Magdalen College, Oxford, and Editor of Sir William Hamilton's Lectures. With Copious NOTES TRANSLATED for the American edition. 12mo, cloth, 1.50.

THE CRUCIBLE; or, Tests of a Regenerate State; designed to bring to light suppressed hopes, expose false ones, and confirm the true. By Rev. J. A. GOODHUE, A. M. With an introduction by Rev. E. N. KIRK, D. D. 12mo, cloth, 1.50.

SATAN'S DEVICES AND THE BELIEVER'S VICTORY. By Rev. WILLIAM L. PARSONS, D. D. 12mo, cloth, 1.50.

SEP 22 1939